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Compressed Air

A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. IX. NEW YORK, MARCH, 1904. No. 1.

"Compressed Air,"

OR

THE COMPRESSED AIR MAGAZINE.

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

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Those who fail to receive papers promptly will please notify us at once.

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VOL. IX. MARCH, 1904. NO. 1

A New Volume of "Compressed Air."

Compressed air is attracting more and more attention in the engineering profession as its availability for power transmission and the operation of labor saving tools is realized. The engineer or practical man who is interested in the subject is glad to profit from the experiences of others and to know of the new devices—many of importance—which are constantly making their appearance. The technical papers of a general nature print more or less of interest on the subject, but the busy man does not have time to search through the mass of other material to find that which he desires. It was to meet the demand for this information by consolidating all of interest on the subject that COMPRESSED AIR was founded eight years ago.

Every new publication points out a long felt want as the reason for its establishment. No matter how cleverly this claim may be presented, time only will serve to demonstrate its truth. COMPRESSED AIR is now starting on its ninth volume. It is beyond the experimental stage. Time has shown that such an enterprise was not a mistake. Its value is now unquestioned and it has come to be recognized as the authority on the subject of compressed air. It is read carefully in every land where compressed air is used, while the leading manufacturers of compressed air machinery recognize its value as an advertising medium.

The size of COMPRESSED AIR has been limited by the literature on the subject. It has been our aim to cover the subject in question and cover it fully, but not to invade other fields. Much important material has been published in abstracts of papers presented before various engineering societies. Through the courtesy of our friends of the technical press, articles and illustrations of interest from other publications have been gathered together for the benefit of the readers of COMPRESSED AIR. These have appeared entire, if very important, or otherwise in a condensed form. Men who have been prominent in the development of compressed air machinery have favored us with information. By combining all these, COMPRESSED AIR has fulfilled its claim. It has told the story of the progress of compressed air.

The practical man or the engineer who wants to keep in touch with the subject will find COMPRESSED AIR a very valu-

able addition to his library. Of special value, as a matter of reference, is the list of patents which is now a regular feature of each issue. Every patent secured for a device, in which compressed air figures in any way, is noted. Those of particular importance are illustrated. The number of these patents is steadily increasing and gives proof of the advance being made in this field.

Aiming to assist and enlighten its readers, COMPRESSED AIR is at all times glad to receive inquiries for publication in its columns. Papers and shorter communications will gladly be given space at as early a date as possible after their receipt.

Every effort possible will be made to have the new volume surpass all previous ones. In order to do this it will require the co-operation of our friends. This we trust we may have as generously and fully as in former years.

The Storage Air Brake System.

To the public at large there is no more important application of compressed air than the air brake. The safety and increased speed directly resulting from its use cannot be calculated. Its success in the operation of steam cars was naturally followed by its application to street transit service, particularly after the rapid development of the electric street car. The conditions on the steam railway have so far precluded any storage air system. Steam is comparatively plentiful and the amount needed to operate a small air compressor is insignificant compared with the total amount generated. With the adoption of air brakes on the electric street car it was natural that the same general plan should be followed, the motive power, electricity, being utilized to operate a small air compressor. Conditions on a steam railway and a street car line differ materially. The slower speed and the shorter trip of the latter make it possible to carry the supply of compressed air needed for one trip without necessitating a storage reservoir of impracticable size. This fact has been recognized for some time, but certain features of the subject have heretofore prevented the general adoption of the new system.

Special interest is shown, therefore, in the action of the St. Louis Transit Company, of St. Louis, Mo., in establishing a system of storage air brakes on all its cars. A description of this installation and the equipment is given in this number. The operation of this plant will be awaited with great interest, as its success or failure will have a great influence on the future equipment of the modern street railway.

A Storage Air Brake System Adopted at St. Louis.

An important change has marked the air brake system, which is now being installed by the St. Louis Transit Company, of St. Louis, Mo. This company is preparing its rolling stock and system for the great demands which are sure to be made on it during the coming summer on account of the Louisiana Purchase Exposition, and is taking advantage of every method which may improve traffic conditions. Instead of equipping the cars with individual air compressors for operating the brakes, a system of storage air brakes has been adopted. Storage air brakes have been used to some extent for the past five years, but this is the first time they have been exclusively adopted by any large system. This fact attaches importance to the installation, and makes a description of special interest to the readers of COMPRESSED AIR.

According to the officers of the St. Louis Transit Company the storage sys-

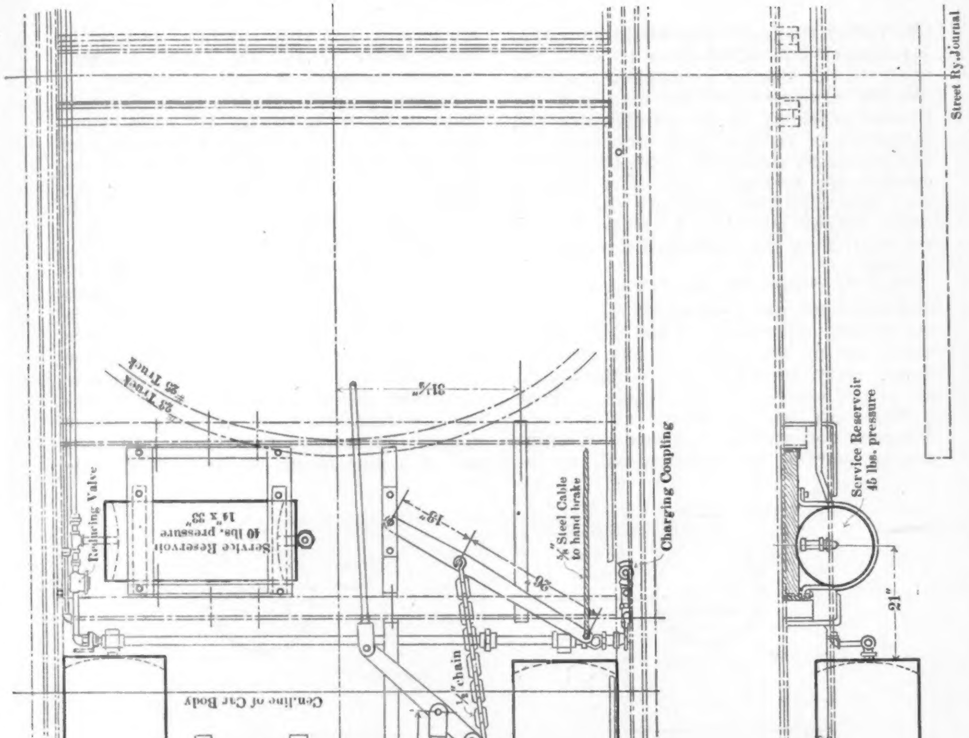


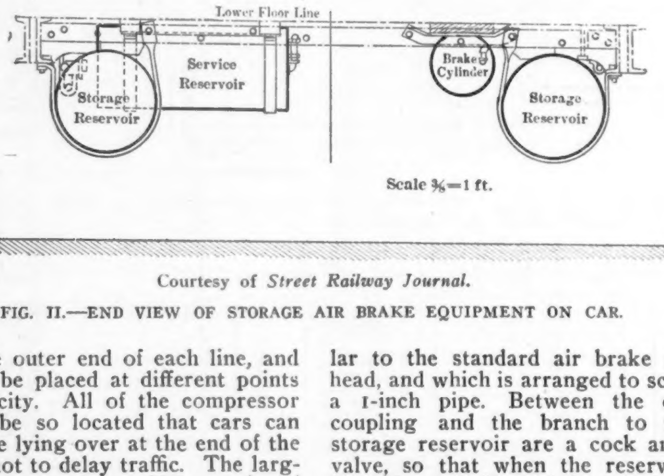
FIG. 1.—PLAN AND SECTIONAL VIEW OF STORAGE AIR BRAKE EQUIPMENT ON CAR.

tem rather than an independent compressor system was adopted on its cars, because of the smaller investment required for the equipment of the road and the greater economy in the maintenance and operation of a few stationary compressor plants as compared with those of a compressor on each car. The officials also state that they consider the system more reliable and less likely to fail on the road than the individual compressor system.

The St. Louis Transit Company has ordered 1,500 car equipments of storage air brake apparatus. This will equip every car on the road. It has also ordered forty motor-driven compressors, all of the same size and design. These compressors will be placed at eighteen different compressor stations. A compressor station, for instance, will be located at the outer end of each line, and others will be placed at different points within the city. All of the compressor plants will be so located that cars can charge while lying over at the end of the line, so as not to delay traffic. The largest compressor stations will be equipped with three compressors. In most cases the compressing equipment will be located in neat brick buildings, although in some cases where the terminus is in a fine residence district it may be located in a vault under the street.

Besides the compressing stations permanently located, a number of portable compressing stations mounted on cars will be built. These will serve several purposes. They can be used on the ends of lines operated only in summer, they can be employed during construction for various purposes as well as to supply air for brakes, and they can also be used in emergencies to take the place of a stationary compressor during repairs.

Figures I. and II. show a plan, elevation and section of the storage air brake equipment on the cars, which is being supplied by the Westinghouse Traction Brake Company. As will be seen, there are two storage reservoirs, one on each side of the car, each being 18 inches in diameter by 6 feet long. Each has a capacity of about 10 cubic feet, so that the air storage of 20 cubic feet at 300 pounds pressure, carried in these reservoirs, is equivalent to approximately 100 cubic feet at 45 pounds pressure, which is the pressure used in the service reservoir and brake system. The outlets for charging the reservoirs are at the side near one of the storage reservoirs, and consist of a pipe fitting which is very similar to the standard air brake coupling head, and which is arranged to screw into a 1-inch pipe. Between the charging coupling and the branch to the first storage reservoir are a cock and check valve, so that when the reservoirs are fully charged the cock is closed, and any tendency of the air to leak through it after the coupling is detached will be at once stopped by the check valve.



Courtesy of *Street Railway Journal.*

FIG. II.—END VIEW OF STORAGE AIR BRAKE EQUIPMENT ON CAR.

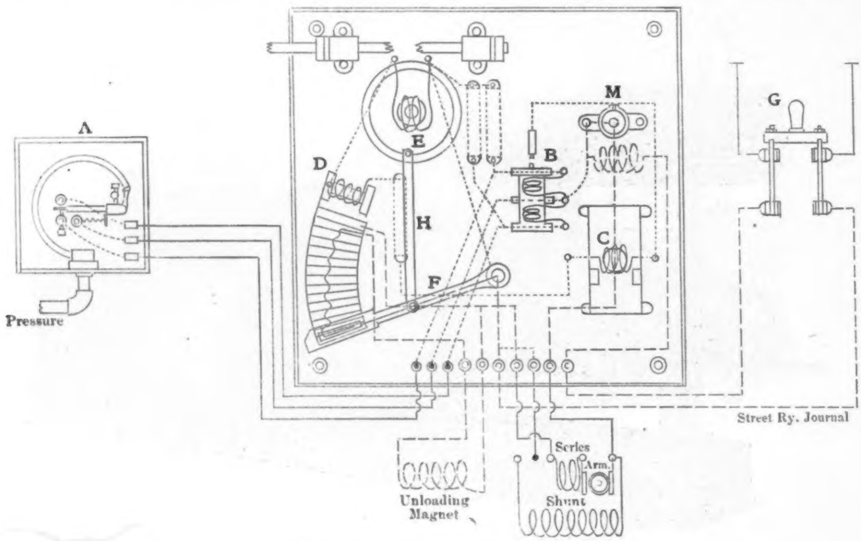
The service reservoir, which corresponds to the ordinary reservoir in the straight brake system, is 14 inches in diameter by 33 inches long, and contains approximately 4,400 cubic inches. Near this service reservoir in the main high-pressure supply piping is placed the reducing valve. This valve, in its operation, is in every way identical with the feed valve of the engineer's brake valve, as used in the ordinary steam railroad

air brake system. The function of this valve is, of course, to keep the pressure in the service reservoir at 40 pounds, which it does very accurately and independently of the pressure in the storage reservoir.

The operating valve on the front platform is the standard O. V. J. valve of the Westinghouse Traction Brake Company, and is practically a three-way valve, which is operated by a handle which can be inserted only when the valve is on the lap. The brake cylinder is the standard 10-inch by 12-inch stroke cylinder of the Westinghouse type, and operates the

on one side just inside the side sills, so that there is no interference with the swivel trucks.

The air compressors will be electrically driven from the trolley circuit and are being supplied by the Ingersoll-Sergeant Drill Company. They are of the tandem compound single acting Class "EC" type, arranged with Westinghouse electric motors connected to Morse silent running chain drive as shown in the accompanying illustrations. The cylinders are 14¼ inches and 6¼ inches in diameter by 12-inch stroke, and are placed in tandem, compressing air in the low pres-



Courtesy of *Street Railway Journal*.

FIG. III.—DIAGRAM OF CONNECTIONS OF AUTOMATIC STARTER.

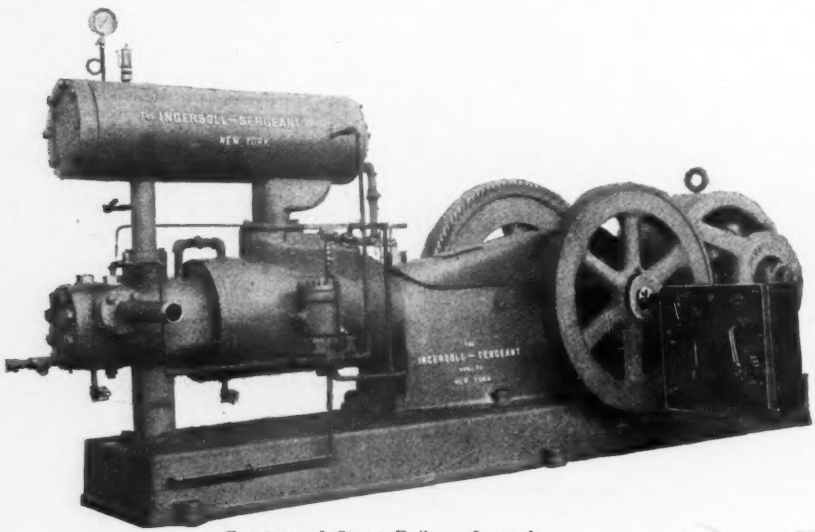
brake rigging in the usual way, with a wire cable connection to a hand-brake handle for emergency use. As will be noticed from the plan all of the tanks are within easy reach of a man standing beside the car, so that they can be easily drained. All the valves, including the reducing valve between the storage and the service reservoirs, are also within easy reach. The piping to the front platform is carried under one side, and that from the platform to the brake cylinder is carried under the other side. The wire cable to the hand brake is also carried

sure cylinders to about 60 pounds on the forward stroke and in the high pressure cylinders to a final discharge pressure of 325 pounds per square inch on the return. They are of the Ingersoll-Sergeant Class "E" design, having forging crank shaft with double balanced wheels, main bearings contained in the semi-tangye frame construction mounted together with the motor on a rigid cast iron sub-base with a special out-board support for the high pressure cylinder through which the intake air passes into the space between the high pressure and low pressure piston

entering the low pressure cylinder through a piston inlet valve.

Both cylinders have mushroom type discharge valves, the air passing from the low pressure cylinder through a specially constructed intercooler to the high pressure cylinder, thence to the storage reservoirs. The storage capacity at each station is of necessity somewhat in excess of usual practice in compressed air installation. This is caused by the fact that at certain times during the day, specially "rush hours," the stations will be called on to furnish more air for charging cars than the actual capacity of the air compressor could supply. These stations are installed in triplicate, having three compressor units, as well as two storage tanks, 36 inches in diameter by 18 feet long. The actual capacity of the compressors when operating at their specified speed of 110 revolutions per minute will be about 100 cubic feet of free air per minute. This gives a maximum capacity to each station of 300 cubic feet. The storage tanks are charged at the higher pressure, 325 pounds per square inch, while the cars will be charged to about 275 pounds per square inch. This excess storage capacity, however is counted on to supply extra air for a short duration only, when there is an extra heavy demand for the same, and the compressor units are of sufficient capacity in themselves to supply the air required during the heaviest duties.

On account of the severe conditions to be met with, the compressor being practically on duty for 24 hours per day, it was decided by the St. Louis Transit Company to make these outfits as nearly automatic in their operation as possible. During the "rush hours" they will be called upon to deliver their full capacity of air, and at other times but a comparatively small per cent. of this. It was, therefore, decided to use an automatic starting and stopping control, primarily governed by a predetermined range in air pressure drop. The compressors pumping up to 325 pounds pressure, when they would be automatically stopped, and when this pressure had dropped to 275 pounds they would then be automatically thrown in operation again.



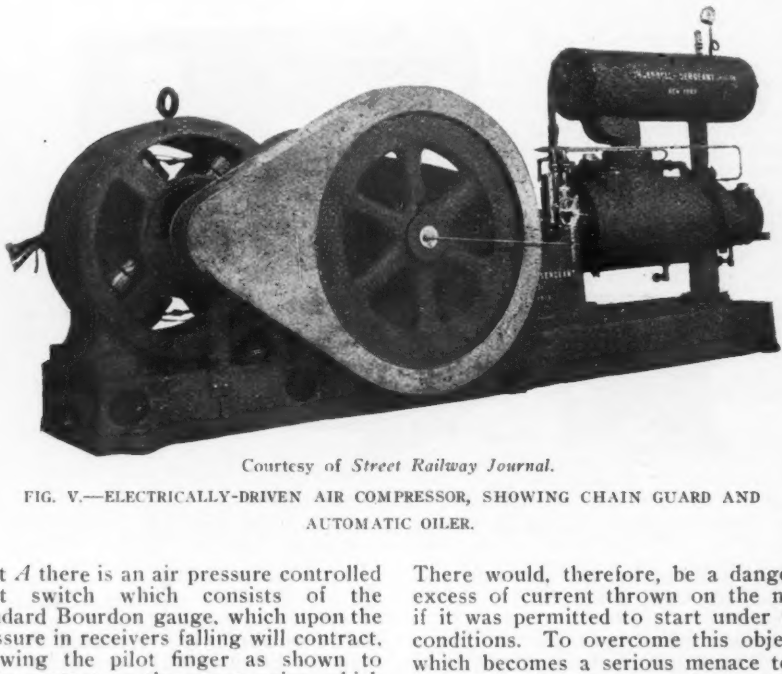
Courtesy of *Street Railway Journal.*

FIG. IV.—ELECTRICALLY-DRIVEN AIR COMPRESSOR, SHOWING AUTOMATIC CONTROLLER AND UNLOADING DEVICE.

Figure III. is a general wiring diagram of the electric connections illustrating the

action of the automatic control. This device is operated from the compressor shaft through worm gearing driving an automatic magnetic clutch which through a connecting link raises the rheostat arm over the resistance plates. At *G* on the wiring diagram is shown a hand thrown switch connecting with the trolley and ground forming the main circuit connection. It cannot, however, be made through the motor until the magnetic switch at *C* is thrown, making a contact at *M*. The primary controlling circuits are all shunted off, the main line having high pressure resistance rods in their circuits.

through this secondary circuit the magnetic switch immediately closes, making contact through the main circuit at *M*. This main circuit passes through the rheostat to motor, and is, in its general action, in all respects similar to the ordinary hand starting rheostat, with the following change, which on account of excessive starting load becomes essential for a successful operation for this type of apparatus. The inrush current required to start an air compressor against its full working pressure load is in the majority of cases from 100 to 200 per cent. over that required for that operation under full working conditions



Courtesy of *Street Railway Journal.*

FIG. V.—ELECTRICALLY-DRIVEN AIR COMPRESSOR, SHOWING CHAIN GUARD AND AUTOMATIC OILER.

At *A* there is an air pressure controlled pilot switch which consists of the standard Bourdon gauge, which upon the pressure in receivers falling will contract, allowing the pilot finger as shown to make contact on the upper point, which in turn short circuits the lower coil of the secondary contractor shown at *B*. The upper coil acting as a solenoid immediately raises its core, making contact through the secondary circuit at *B*, thus throwing the current through the operating coil of the magnetic switch at *C*, holding coil of the rheostat at *D* and the operating coil of the magnetic clutch at *E*. Upon the current being thrown

There would, therefore, be a dangerous excess of current thrown on the motor if it was permitted to start under these conditions. To overcome this objection which becomes a serious menace to the apparatus when it is considered that it may be called upon to start and stop on an average of once per minute throughout the day, there is inserted in the main line a magnetically operated unloader.

This is shown on the side of the low pressure cylinder and consists of the Sergeant type of compound air compressor unloader arranged to be operated by a powerful solenoid in place of the

piston which is used on compressors operated by steam.

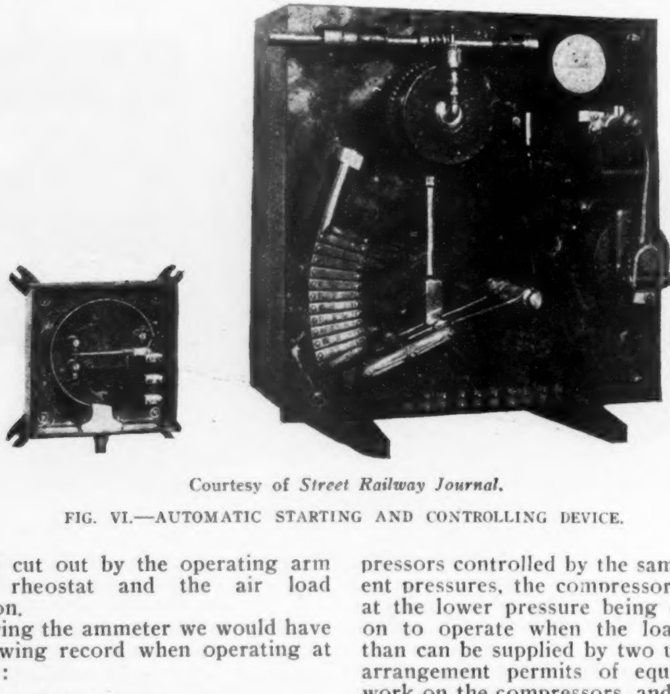
Upon contact being made through the main circuit at *M*, the current is thrown on the motor, and also on this unloading magnetic which is connected in as the last step of resistance of the rheostat, and throws off the air load of the compressor even before the field magnets of the motor are sufficiently energized to start the same. This allows the starting to be accomplished on an inrush current which will not exceed at any time that required for rated working conditions, and, being the last step in the resistance, it allows the entire apparatus to reach practically full speed before it is automatically cut out by the operating arm of the rheostat and the air load thrown on.

Following the ammeter we would have the following record when operating at 500 volts:

Inrush starting current required	52 amperes.
Drop off while getting up speed to	27 "
Upon load being thrown on continuous reading on ammeter from	47-52 "

Upon the high pressure being reached the pilot finger of the pilot control switch makes contact again, this time on the lower contact point, short circuiting the upper coil of the solenoid contractor shown at *B*, thus breaking the secondary controlling circuit at *B* and releasing the entire apparatus from "no voltage release."

The arrangement of the air compressors which are installed in triplicate in the various stations is such that by throwing a double switch in the pilot control circuit it is possible to make any one of them carry the brunt of the load, as the three air pressure controlled pilot switches are set with the low pressure contacting points about five pounds apart, thus putting in action the compressors controlled by the same at different pressures, the compressor thrown in at the lower pressure being only called on to operate when the load is more than can be supplied by two units. This arrangement permits of equalizing the work on the compressors, and so that, in case of accident to one, it can easily be put out of service for repairing. It is intended to have an inspector call at these sub-stations about once or twice a day, at which time any irregularities in the operation can be looked into and taken care of. This inspector is also to fill up the oil reservoirs of the automatic oiling devices.



Courtesy of *Street Railway Journal.*

FIG. VI.—AUTOMATIC STARTING AND CONTROLLING DEVICE.

There are several other points in connection with this type of air compressor, as well as the controlling device, which are of interest.

On account of the high pressure in question it was desirable to do away with any form of high pressure packing, which is liable to give out. It was, therefore, decided to use the tandem construction as shown, in which there is only one low pressure stuffing box. These stuffing boxes are equipped with approved metallic packing and are practically the only air joints on the compressors which require any adjustment.

The intercooler between air cylinders is of a horizontal receiver type, so arranged that it can be tested for leaks and repaired without removing any part except the heads at each end. It is also arranged to take up the expansion or contraction resulting from differences in temperature without any undue strains being met with. The capacity of this intercooler is sufficient, it is claimed, to maintain a practically constant pressure in the same, thus allowing the pressure of air through it to be done at a comparatively low velocity, giving ample time for cooling.

Upon considering the unbalanced pressures which were met with on the cylinders of these compressors, it became evident that some precaution should be used in placing the inlet and discharge valves in the high pressure cylinder, where 260 pounds unbalanced pressure is encountered, in such relative position to the cylinder itself that if any accident befell these valves, protection would be afforded against any broken parts entering the cylinder and thus causing extra damage. It was, therefore, specified that these valves should be placed on the sides of the cylinders and arranged so that the trouble above referred to could not happen.

Among the other points specified by the St. Louis Transit Company was that these compressors would be arranged for entire automatic lubrication, having a capacity sufficient for a 24-hour continual run, and that when not operating the lubricating devices should also be inactive. The outfits were arranged to lubricate the crossheads, crank pins, connecting rods and main bearings by a system of splash lubrication, a double feed mechanically operated oil pump being furnished for the air cylinders.

The electric conditions to be met with are comparatively severe, the voltage varying over the different parts of the line from 400 to 650 volts. This necessitated a special study of starting devices which must not show a material change in operation over this wide range of voltage. This one point practically eliminated the serious consideration of any form of solenoid-controlled controlling device, as the starting period of this type of starter is entirely dependent upon the voltage, and with a fluctuation as large as that at St. Louis, the starting period would change in a direct comparison, thus making it impossible to adjust for the even inrush of current necessary.

The motors which are furnished by the Westinghouse Electric and Manufacturing Company are of special construction, having the field slightly over-compounded to make a strong starting motor and built so as to have a comparatively slight fluctuation in speed over the above range of voltages.

As many of the sub-stations in which these compressors are installed are in neighborhoods where the noise which is inherent with gear driving would become objectionable, it was decided to use the Morse silent running chain drive.

The St. Louis Union Terminal Station.

Compressed air plays no unimportant part in the daily routine at the Union Terminal Station, St. Louis, Mo. Its varied applications, together with the electro-pneumatic high pressure switch and signal system used in the interlocking plants, require a compressor capacity of fully 4,600 cubic feet of free air per minute. At the power plant of the Terminal Station, therefore, the compressors figure quite prominently. The accompanying four views are of the power plant, and illustrate the compressors, receivers and air drying system.

The growth of the use of compressed air in systems of this nature is well illustrated in the history of the compressor plant at the Terminal, since the time of its erection nine years ago.

At the start, an Ingersoll-Sergeant straight line class "A" compressor, which had a capacity of 500 cubic feet of free air per minute, was installed. In

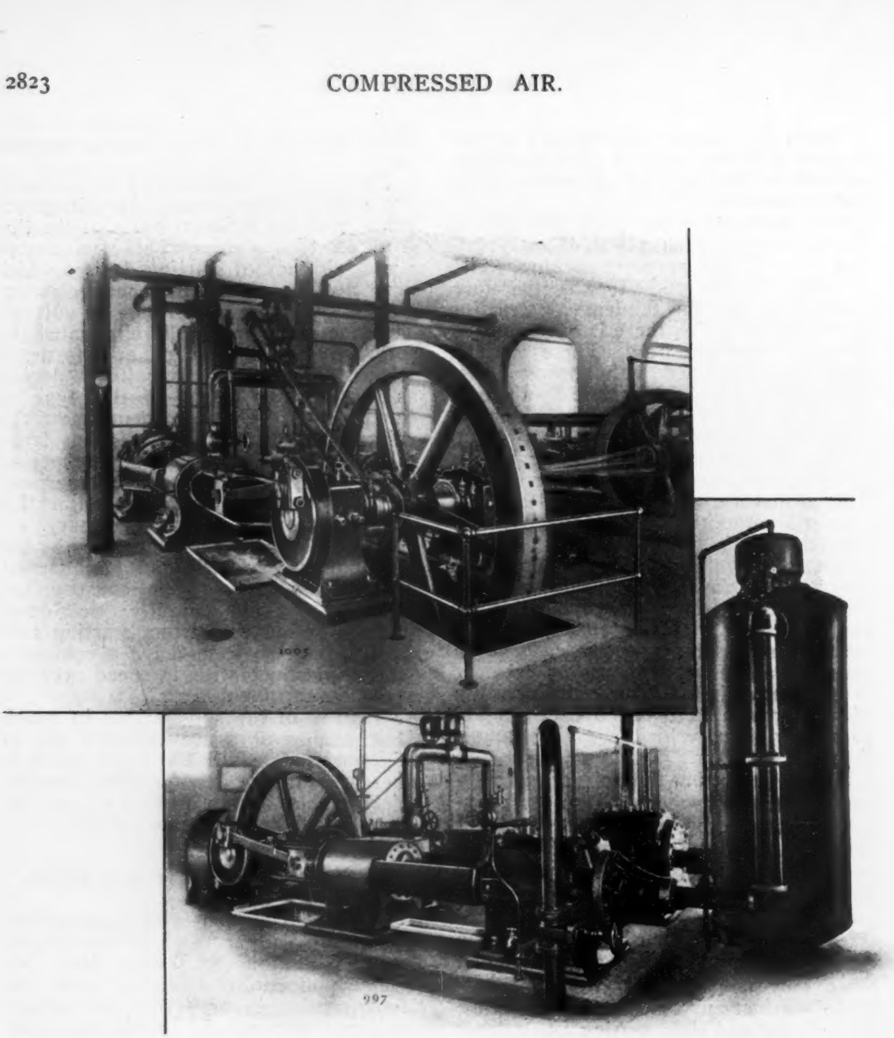


FIG. 1.

the next five years, two Norwalk machines, with capacities of 960 cubic feet each were added. In 1901, it was decided to increase the supply with a more economical type of machine, and an Ingersoll-Sergeant duplex compound compressor, having 20 by 24 simple steam cylinders with Meyer cut-off and 32¼ and 20¼ by 24 piston inlet air cylinders, was purchased.

Figures 1 and 2 show three views of this machine; figure 2 showing the intake box covering the piston inlet pipe, and the opening to the conduit through which a supply of air is obtained outside of the building. The air from all of the compressors passes into three receivers, (Fig. 3) so arranged with by-passes that any one, two or all three can be used as desired. By this arrangement it is pos-

sible to cut out one receiver, in order to clean it without interfering with the operation of the system of the others.

From the receivers the air passes to a separating or drying system, as shown in Figure 4, consisting of four stacks of 38¾-inch pipes each, arranged in two sets, the pipes being about 9 feet long. These are also arranged with by-passes so that it is possible to cut out a set if so desired. With the stacks and pipes there are five (5) tanks for collecting the precipitated moisture so that the air is discharged into the mains with a very small amount of suspended moisture.

The air is used for various purposes throughout the yards, shops and depot, in addition to the interlocking system. In the depot building it is used on the letter presses, and in the operation of

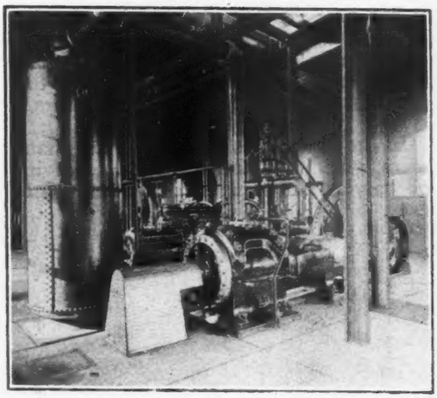


FIG. 2.

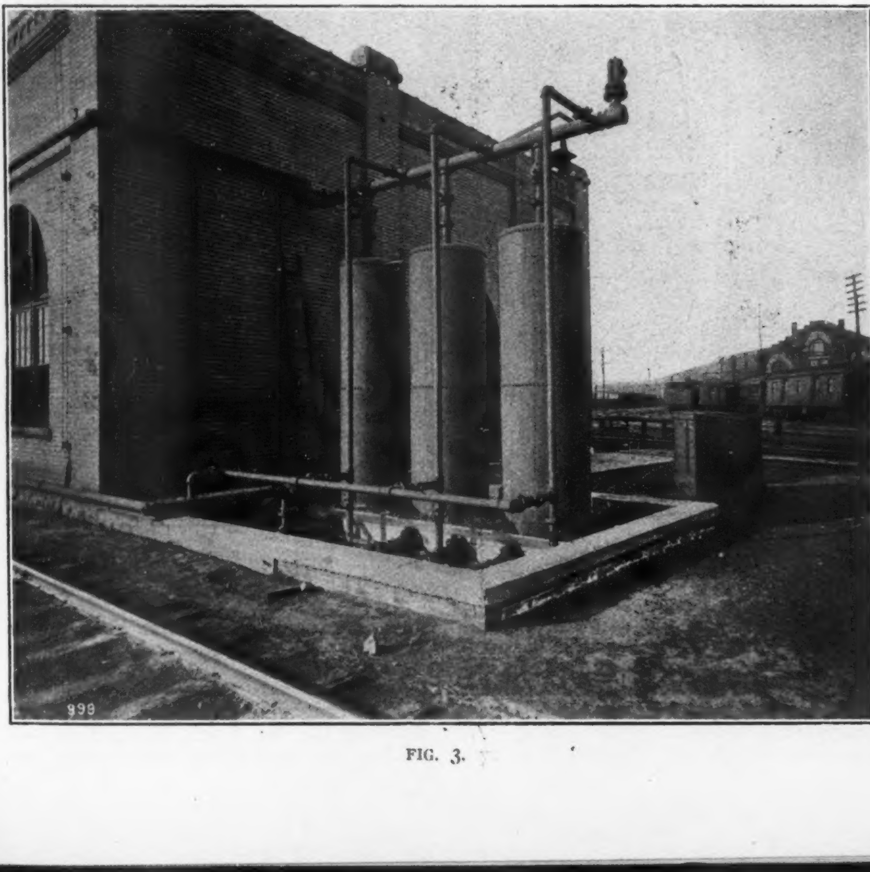


FIG. 3.

the pneumatic tube system. In the yards it has proved its usefulness for cleaning carpets and cars, for air jacks, pneumatic tools, hoists for coaling locomotives, elevators for filling the sand storage bins and for charging the air brake system on passenger trains.

In the shops it is utilized for trip hammers, pneumatic tools, forges, emptying oil barrels and a number of other minor uses.

Ingersoll - Sergeant duplex compound compressors, 20 by 24-inch simple steam cylinders, with Meyer cut-off and balanced valves, and 32¼-inch and 20¼-inch by 24-inch piston inlet air cylinders. This plant will, undoubtedly, be of much interest to the host of visitors who will visit St. Louis during the Exposition time, and it will attract much attention among railroad men, as well as others directly interested in air compressors.

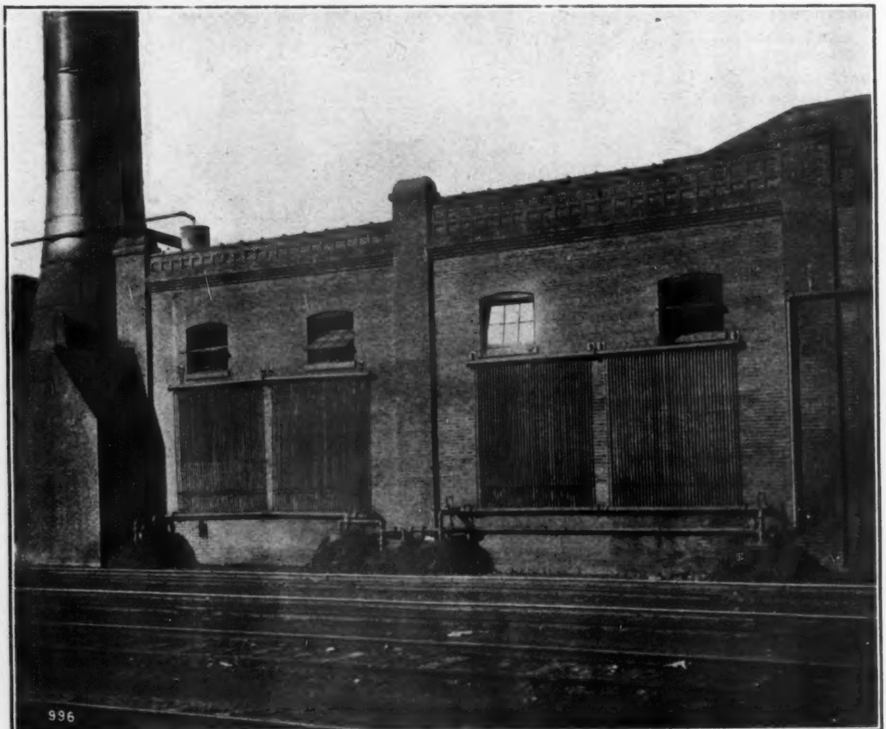


FIG. 4.

To take care of the enormous traffic expected during the St. Louis Exposition, this year, the Terminal Association is at present erecting a new power plant for supplying air for the largest interlocking system in the world. At this plant the air will be supplied by two

The Compressed Air Power Plant at the St. Louis Exposition.

The central compressed air power plant at the St. Louis Exposition will contain two main compressing units; one

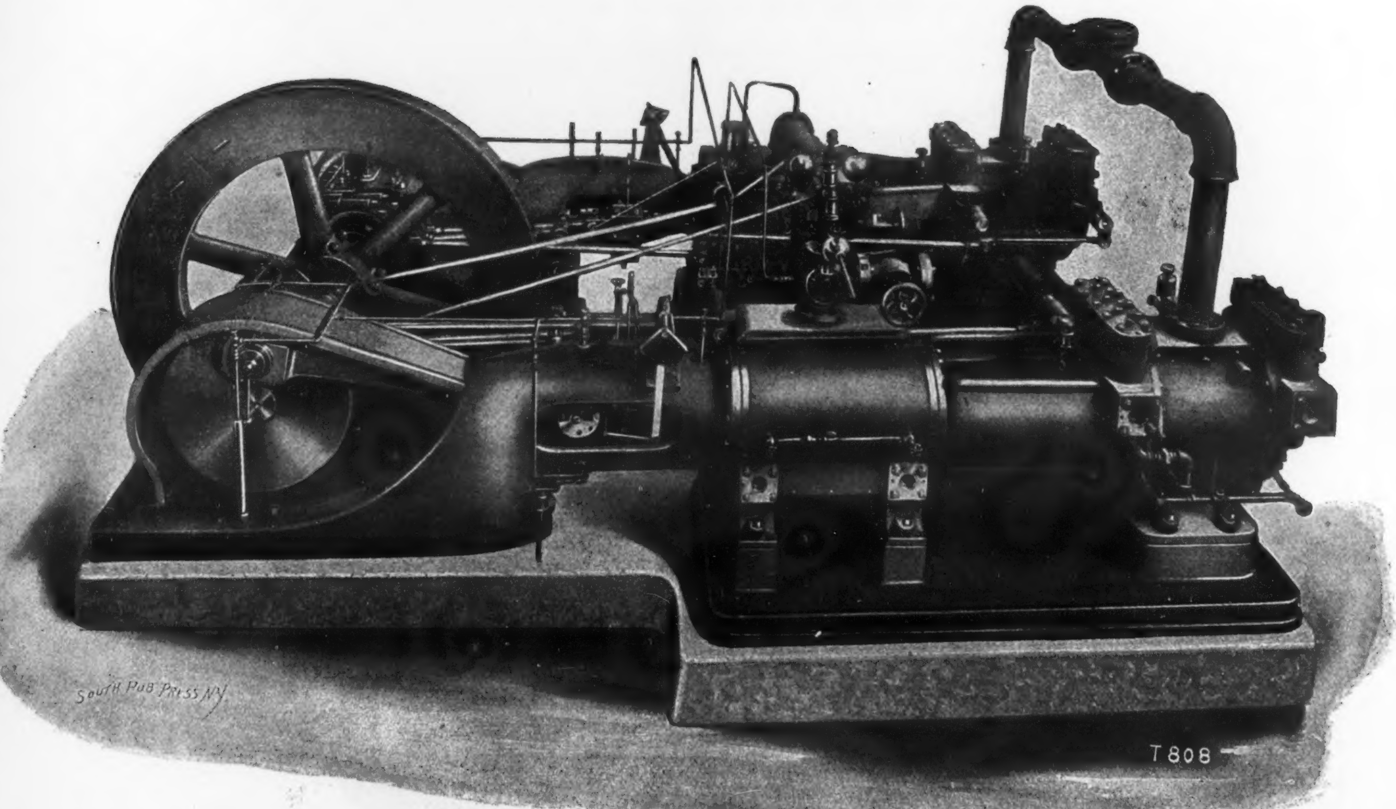


FIG. I.—CINCINNATI GEAR AIR COMPRESSOR.

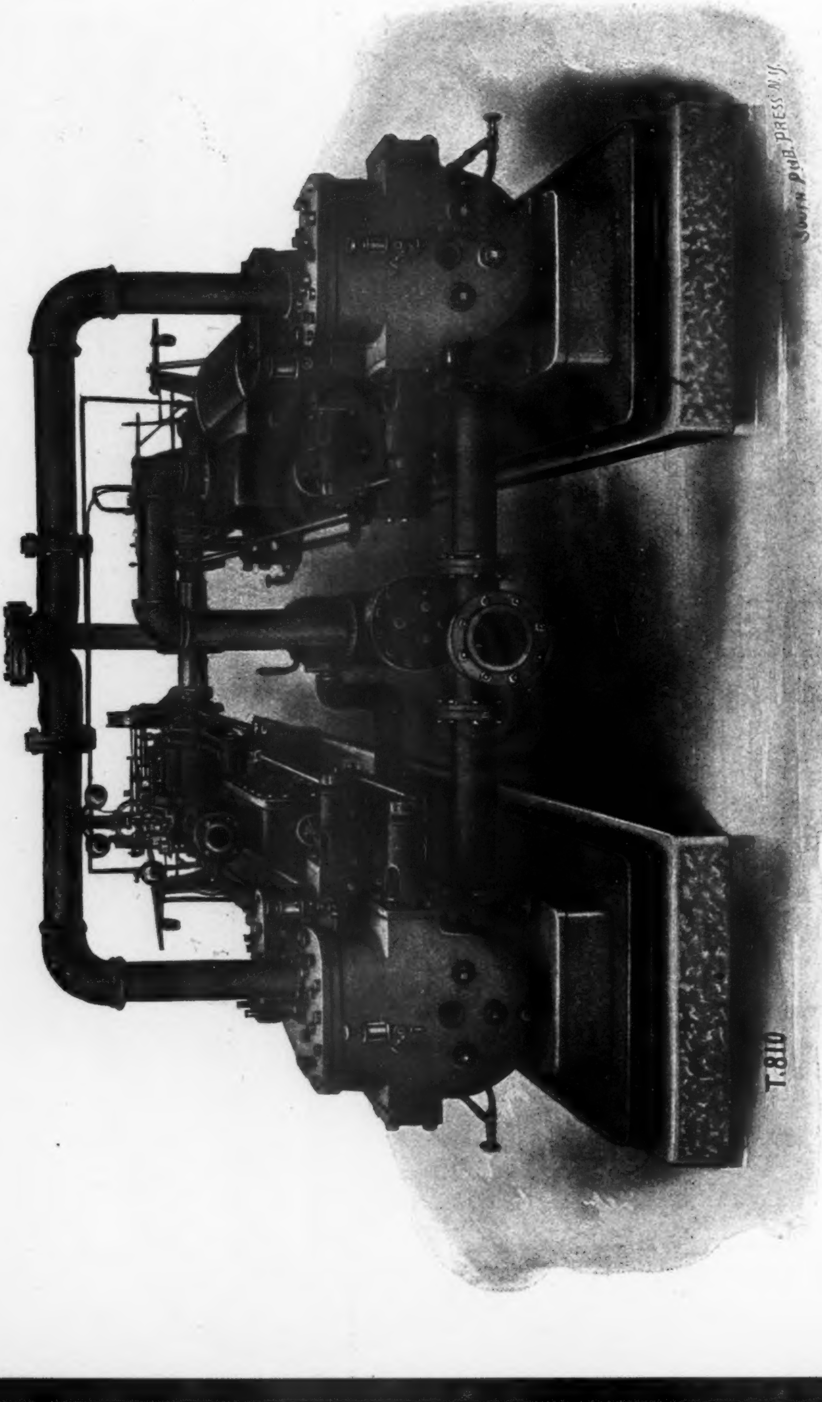


FIG. II.—CINCINNATI GEAR AIR COMPRESSOR.

cross-compound two-stage Cincinnati-gear compressor, having 13 and 24-inch steam cylinders, 22 and 14-inch air cylinders and 24-inch stroke, with a displacement at 125 revolutions per minute of 1,300 cubic feet per minute, and one cross-compound two-stage Meyer-gear compressor having 12 and 20 inch steam cylinders, 18 and 11 inch air cylinders and 18-inch stroke, with a displacement at 100 revolutions per minute of 530 cubic feet per minute. The first machine is to supply the general compressed air requirements of the Exposition, while the second is to supply the transportation exhibits. The larger machine is of special interest as being the first compressor of its type publicly exhibited.

The general construction of one of these machines is shown in Figures 1 and 2. The frames, as will be noted, are of massive construction, with a long bearing on the foundation, while the steam and air cylinders, joined in the direct line of thrust by heavy cast iron housings, are also supported by bed plates under their entire length, the weight of each side being thus taken on two large bearing surfaces extending to the ends of the machine. The general construction comprises removable quarter boxes and main bearings, steel forged connecting rods, with wedge take-up, specially large crank and wrist pins and cast steel cross heads, with adjustable babbitted slippers, top and bottom, working in bored guides. The steam valve-gear is of a four-valve type. Steam distribution is effected by means of short, double-ported slide valves, working at either end of the steam chest on a valve face as close as possible to the cylinder bore, the port volume

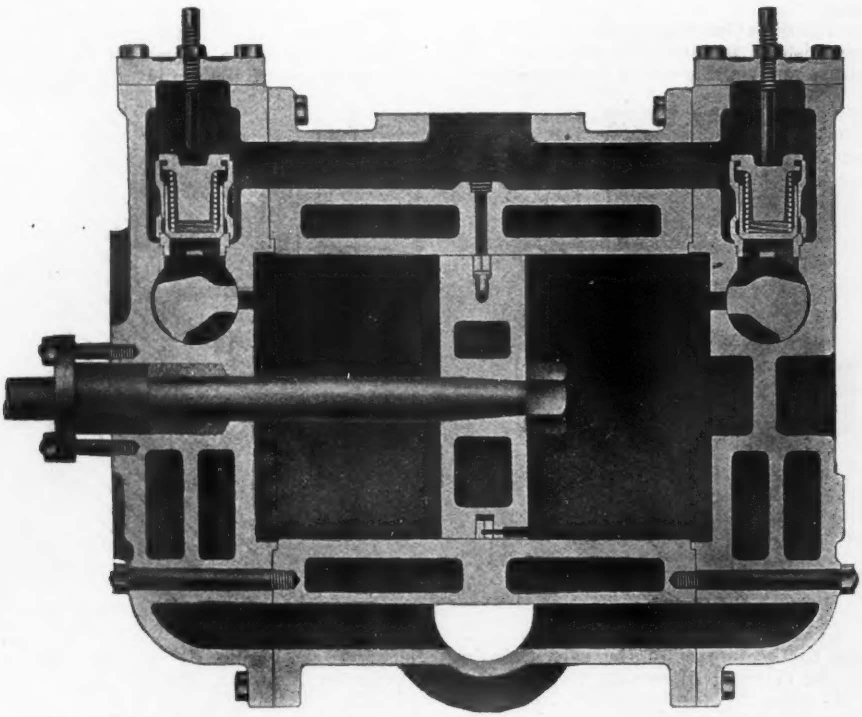


FIGURE 3.

being restricted as far as the large valve area will allow. The exhaust valves are of the Corliss rotary type and are placed at the bottom of the cylinder. This construction has been followed in order to produce a valve gear having the essential advantages of a Corliss, namely, separate passages for the steam and the exhaust, with corresponding reduction in cylinder condensation, together with short, straight ports and small clearance. The Corliss releasing gear has been eliminated, the action being positive throughout.

The air valve gear is, however, the distinguishing feature of this machine. The noise and rapid wear of the poppet valve, due to the impact of the valves closing at the reversal of stroke, is eliminated, it is said, by mechanically closing the passages underneath the poppet valve, and leaving a cushion of air upon which the latter seats. The action of the valve gear is indicated by Figure 3, showing the general arrangement of the cylinder, and Figures 4, 5 and 6 showing the position of the valve at various points of the stroke.

At the beginning of the forward stroke of the piston, indicated by position 1 in Figure 6, the mechanical valve, *A*, as shown in Figure 4, is just closing the port, *B*, the discharge edge of *A* being line in line with the upper edge of the port, *B*, and the valve moving in the direction shown by the arrow, *C*. After the piston advances a short distance, the valve has reached the position shown in Figure 5, in which the inlet edge of the valve, *D*, is just coming in line with the lower edge of port, *B*. The valve continues to move in the direction of the arrow, *C*, until about mid stroke, when it reverses to the direction shown by arrow, *E*, bringing the valve back to the position shown in Figure 5 at the end of the stroke, corresponding to position 3 on the ideal card shown in Figure 6. On the return stroke, the valve still moving in the direction of the arrow, *E*, returns at position 4 (Figure 6) to the position shown in Figure 4, the discharge edge of valve, *A*, being in line with the upper edge of the port, *B*, and opening.

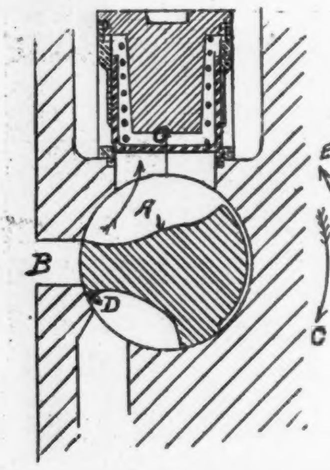


Fig. 4.

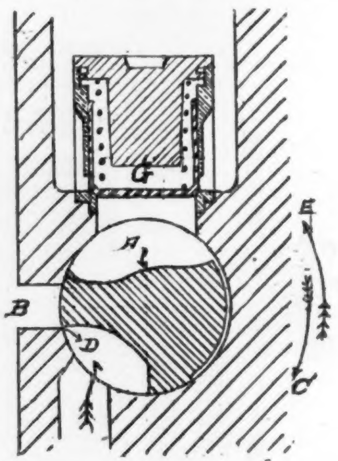


Fig. 5

After the mechanical valve opens, the poppet valves, *G*, which have had the entire return stroke in which to seat, prevent the flow of air back from the discharge passages to the cylinder, and remain closed until position 5 in Figure 6 is reached, when the pressure inside the cylinder slightly exceeds the pressure in the discharge passages. The poppet valves, *G*, thereupon open and remain open until position 1, Figure 6, is reached, at which point the valve *A*,

which in the meantime has changed its direction to that shown by arrow, *C*, has resumed the position shown in Figure 4, thus leaving a volume of air under discharge pressure in the space between the mechanical valve and the poppet valve, permitting the light springs back of the poppet valves, *G*, to seat them easily and gently during the return stroke.

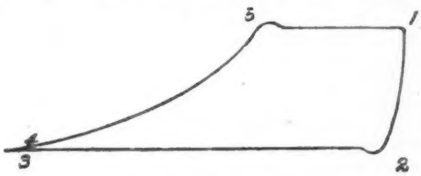


Fig. 6

It is thus claimed that the three fixed points in the compression cycle, namely, the opening of the inlet, the closing of the inlet and the closing of the discharge are positively and mechanically controlled; the opening of the discharge, which is the only variable point in the cycle, is controlled by the automatic poppet valves, which are relieved, however, of the necessity for quick closing, and are consequently free from the objectionable features of noise and rapid wear.

These machines are built by the Laidlaw-Dunn-Gordon Company, of Cincinnati, Ohio.

Explosion in Compressed Air Pipes at Aberbeeg Colliery, Monmouthshire.*

On Wednesday, April 9, 1902, at about 4 P. M., an explosion occurred in the compressed air pipes in the pit shaft, and a column of fire shot up the shaft and set fire to the headgear carrying the winding pulleys. The detonation of the explosion was so loud that it alarmed the neighborhood, and a number of persons flocked to the pit to ascertain the cause, and several of them rendered assistance in conveying water, by which the fire on the headgear was extinguished before it had done any material damage. The point of rupture in the pipes, from which the flame apparently issued, was about 10 yards down the shaft, and from there to the bottom of the shaft the pipes were more or less shattered; some were blown across the shaft (about 16 feet), and lodged behind the 18-inch pump column, and the plates were flattened out. The damage did not extend much beyond the bottom of the pit shaft. The shaft is 100 yards deep, with two landings, the one at 80 yards down and the other at the bottom. At the upper landing, known as the "Fault landing," there is a hauling engine situate about 10 yards from the shaft; the explosion shatterd the throttle-valve chest of this engine. The valve was closed at the time, but the engine was not damaged. At the bottom landing there is another hauling engine situated about 30 yards from the shaft; this was not affected, and the force of the explosion in this direction ceased at a stop-valve about 5 yards from the shaft. This stop-valve was not damaged, but the pipes were shattered almost close up to it. The air-compressing plant consists of a double horizontal engine of the following dimensions, viz.:

Steam cylinders	22 in.	diameter.
Air cylinders	26 "	"
Stroke (length of)......	42 "	"

The air cylinders have the usual water jackets or tubs. Prior to the explosion the heat of the water in the tubs had not been tested by thermometer, but since tests have frequently been made and the temperature at the overflow outlet found to be 70 to 75 degrees. The air is driven into a receiver situate about 8 feet behind the engine. This receiver is 20 feet long, 5 feet diameter, with hemispherical ends, and it has a blow-off or safety valve loaded to a pressure of 60 pounds per square inch. No damage was done to the pipes and receiver between the point of rupture in the shaft from which the flame apparently issued and the compressor. The engine quivered for an instant from the shock, but was not apparently injured; it was at the time going about 28 revolutions per minute. The air cylinders were lubricated by a mixture of soft soap and water—about 2 pounds of soap to 1 gallon of water—and the spindles (or hinge bars) of the inlet and outlet valves were lubricated by "Valvoline" oil. About 2 gallons of the former and 2 quarts of the latter were used every twenty-four hours. After the explosion these lubricants were tested by Mr. John Parry, analytical chemist, of Newport, Mon., to ascertain

*A paper by R. Jordan, read before the South Wales Institute of Engineers.

their flash-point, with the following results, viz.:

(1) Soft soap and water lubricant—
No ignition at 212 degrees; no gas evolved.
Readily ignited at 600 degrees; barely at 500 degrees Fahr. when evaporated to a black semi-solid mass.

(2) Valvoline oil lubricant, for valve spindles:
No ignition at 212 degrees; no gas evolved.
Ignites (flash-point) at about 300 to 350 degrees Fahr.

In the air receiver, which was opened after the explosion, there was a solid combustible deposit about 2 inches thick. This was tested for the flash-point. Result as below:

(3) No ignition at 212 degrees; no gas evolved.
Ignited readily at 400 degrees; barely at 350 degrees.

A liquid deposit which we had previously drawn off gave the following result:

(4) No ignition at 212 degrees; no gas evolved.
Readily ignited at 600 degrees; barely at 500 degrees.

This is the same as the result obtained from the soft soap and water lubricant, although the flash-point of this might have been expected to be somewhat lower than that of the soap and water, from the Valvoline used for the spindles, but the quantity of Valvoline carried off by the oil from the spindles would probably be very little. Prior to the explosion no observation had been taken of the temperature of the compresed air between the cylinders and the receiver; afterward a thermometer was fixed in the pipe as near to the cylinders as it could be placed. The highest reading observed was 325 degrees Fahr., and it ranged from that down to about 300 degrees. After a time the mercury in the thermometer boiled and the particles separated in the tube; consequently the readings were discontinued, and other events transpiring since my following the matter up. The compressed air was used for driving two hauling engines and several Cameron-type pumps. The speed of the compressor was about 28 revolutions per minute for the pumps only, and about 42 revolutions per minute when the hauling engines were going at the same time as the pumps. Some time prior to the explosions ignitions had occurred in the air receiver, but no explosion, and no damage ensued except the inconvenience and loss of time in stopping to extinguish the combustion.

Similar Explosions at Other Collieries.—The author's attention had not before this been called to any similar explosion in this district (*i. e.,* Monmouthshire), but he afterward found that explosion and ignition had been experienced at several collieries in the district, but less violent in effect than the one at Aberbeeg. Since that a very violent explosion occurred at another colliery in Monmouthshire, doing considerable damage to the plant. At Ryhope, in the County of Durham, an explosion occurred in March, 1883, doing very extensive damage. This was reported upon by a committee appointed by the North of England Institution of Mining and Mechanical Engineers, which report appeared in the *Transactions* issued November 23, 1888, part v., vol. 37. At Newbattle, Scotland, ignition occurred in the compressed air receiver without explosion, in February, 1888. This is described in a paper on the "Use of Light Mineral Oils," read by Mr. John Morison before the North of England Institute, which appears in the *Transactions* issued March 30, 1889, parts i. and ii., vol. 38. At Clifton Colliery, Northamptonshire, an explosion occurred at the air compressor and the air receiver in May, 1897. Ignition had previously occurred in November, 1895. A paper on this explosion was read by Mr. T. G. Lees at a joint meeting of the Chesterfield and Midland Counties Institution of Engineers and the Midland Institute of Mining, Civil and Mechanical Engineers, which appears in the *Transactions* of the Federated Institution of Mining Engineers, issued in April, 1898, part iv., vol. 14. It is stated in this paper that an explosion occurred in a compressed air receiver at "Carn Bora" (query, "Carn Brea") Mine, Cornwall, in August, 1885; also that in America and on the Continent a number of explosions and ignitions had happened. It is evident that wherever air compressing machinery is used there is the same liability to ignition and explosion as experienced at the places hereinbefore referred to. Therefore it is important to ascertain the cause of the same, and to take the precautions necessary to avoid them.

Cause of Explosion.—As to the cause of explosion, the cases hereinbefore named

abundantly prove the fact of inflammable vapor being produced from the lubricating material used in the air compressing cylinders and from the solid deposit therefrom in the air receivers by the high temperature of the compressed air. As to how such inflammable vapor may be ignited and exploded the following observations are submitted: In connection with the Ryhope explosion the deposit found in the pipes and air receiver was said to be a mixture of coal dust and the lubricant carried over from the air cylinders, and might be said to "consist of coal dust, mineral oil, soft soap and water." Professor Bedson, of the Durham College of Science, Newcastle-upon-Tyne, ascertained by experiments that the coal dust alone would ignite at a temperature of 291 degrees Fahr. when heated in a current of air at atmospheric pressure. At a pressure of 60 pounds per square inch he ascertained that the temperature of ignition of the coal dust was the same as with air at ordinary pressures, but when ignition occurred a more intense heat was produced, and he thought it highly probable that, under a pressure of 60 pounds per square inch, the deposit, consisting of a mixture of coal dust, mineral oil, etc., "might have been ignited in the same manner as in the experiments with the coal dust." Professor Bedson's experiments are fully detailed, with illustrations, in the paper on this subject already referred to. In connection with the Clifton Colliery explosion, it was thought that "the temperature of the compressed air had risen from some cause above that of the flashing and ignition points of the oil, and so caused the oil to volatilize and by some means to initiate the ignition of the vapor so formed"; and the paper on this subject states in effect that if any hot air were left in the cylinder at the end of the stroke it would heat the incoming air, and result in a higher temperature at the end of the stroke than if no hot air had remained in the cylinder from the previous stroke; also that a badly fitting outlet valve allowing a leakage of hot compressed air to return from the receiver into the cylinder would produce the same result, and an outlet valve sticking and only slightly opening would throttle the discharge, thus increasing the pressure and the temperature. It was also thought possible that a spark had been produced in the cylinder by the friction of the piston if allowed to work in a dry state, or that spontaneous combustion of the deposit (1½ inches to 2 inches thick) found in the receiver had taken place, and so ignited the explosive vapor. In connection with the ignition at the compressed air receiver at Newbattle Colliery sparks were observed to blow out from the joints of one of the pipes near the receiver, and the pipe was nearly red hot. The joints were made of india rubber insertion, which, when taken out, were found to be charred and burnt through. This ignition was thought to have been occasioned by the volatilization of the lubricating oil that had been used, which was afterward found to have a flash-point of 295 degrees Fahr. This oil had been used instead of lard oil (owing to a temporary want of the latter), which the attendant had instructions to use, and which had been used for years and was beyond suspicion, and had been selected for the purpose under the knowledge of what had occurred at Ryhope. In addition to the foregoing evidence of the occurrence of ignition, information has been received of a case in Monmouthshire where the attendant observed a condition of incandescence at the compressor, which was immediately stopped and opened out, when it was found that the discharge pipe from the cylinder was almost choked with deposit; and within the last three months, of a colliery in the adjoining county, where sparks (or flame) had been seen to issue from a joint in the pipes of a compressed air column in the pit shaft. The mechanical engineer of this colliery, having heard of the explosion at Aberbeeg, named the circumstance with a view to obtaining information. The foregoing cases furnish sufficient proof of the source of explosions in compressed air plants—viz., explosive vapor from the lubricants used in the air cylinders, and explosive vapor from deposit in the air pipes and receivers; the vapor being produced by high temperature of the compressed air and ignited by the spontaneous combustion of the deposit.

Precautions to Avoid Explosions, etc. It is therefore obvious that the precautions necessary to avoid explosion or ignition are: (1) Reducing the temperature of the compressed air to the lowest possible point below the flash-point of the lubricants used, and below the point of spontaneous combustion of the deposit.

(2) The constant observation of the temperature of the compressed air leaving the cylinders, and record of same. (3) The use of lubricants of the highest possible flash-point, and such as may be least likely to produce solid deposit. (4) The frequent removal of the deposit from the cylinders, valves, receivers and all accessible pipes, and the daily withdrawal of any liquid deposit from the air receivers. The author refrains from making any suggestion as to the mechanical arrangements most suitable for reducing the temperature of the compressed air, beyond stating that, by compound compression, in a case which has been brought under his notice, air which entered the low-pressure cylinder of a compound compressor at an initial temperature of 94 degrees left the high-pressure air cylinder at a temperature of 235 degrees after compression to 75 pounds per square inch. He also is aware of two cases where water jets falling upon the outer surface of the air receivers have been beneficial, and reduced the temperature of the air considerably. In connection with the Aberbeeg explosion, one circumstance may be worth relating, viz., in the examination made after the explosion a stop valve in the air pipes at the pit bottom was found to be almost closed, and the question arose whether some one immediately before the explosion had mischievously and suddenly closed the valve, and whether, with the compressor going at 28 revolutions per minute, the sudden impact of the air upon the closed valve had ignited combustible matter in the pipes and so caused the explosion. Against this notion it was thought that possibly some one of the men engaged in examining the extent of the damage done by the explosion had moved the valve and left it nearly closed. On being questioned those men were emphatic in stating that such was not the case and that they had not touched the valve. On the other hand, the hitcher in charge of the pit bottom at the time of the explosion was equally emphatic in declaring that no one could have meddled with it without his seeing him, and that no one did so before the explosion. One circumstance that gives some little color to the idea that the explosion was caused by the sudden closing of the valve is the fact that no damage was done to the pipes on the in-bye side of that stop-valve and none to the pipes on the out-bye side of the point about 10 yards down the shaft, which was supposed to be the first point of rupture and whence the flame was believed to issue, all the damage being confined to the pipes in the shaft between these two points. The valve in question was a "wheel-valve." Since then the wheel has been removed to prevent any one from tampering with the valve. It might possibly be worth while to add this to the list of precautions. This circumstance may appear trivial, but when obscurity as to cause of disaster exists it is well to take note of every point in connection with it.

Caskey Pneumatic Punch.

Attention has already been called in COMPRESSED AIR to the Caskey Pneumatic Punch, which is another successful application of compressed air to practical uses. The first Caskey punch, while of crude design compared to the finished products of the market to-day, was considered very efficient. It actually punched 90 per cent. of the holes in two torpedo boat destroyers. Two years later, these machines were placed on the market, the interim having been devoted to their perfection and improvement. Further changes have been made so that the manufacturers claim that the present machines are vastly superior to the one originally placed on the market.

The legitimate field of this pneumatic punch is practically unlimited, but it is of particular value in the machine shop. Durability, accuracy, lightness of weight, convenience and speed are some of the advantages which are combined and it is particularly invaluable where it is cheaper to remove the tool than the work. The accompanying illustration shows the construction and operation of the punch.

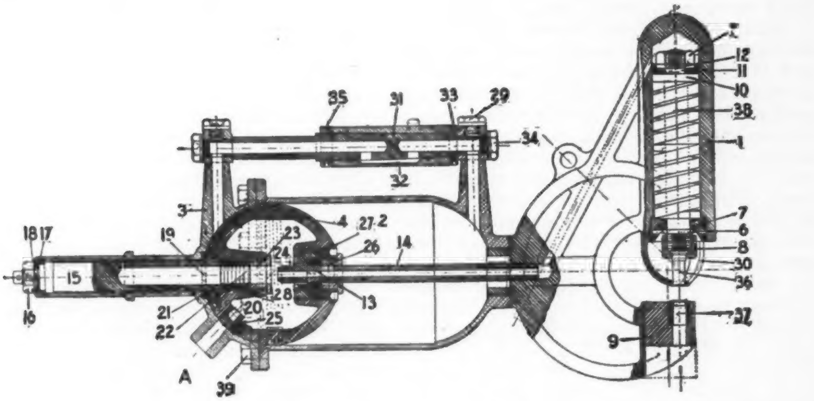
The ball piston, 4, carrying tail rod or intensifier, 15, is seen in extreme rearward position, the extremity of the stationary hollow rod, 14, being at the approximate centre of the ball piston. When the piston begins its stroke, impelled by the constant air pressure from A, the rod, 14, telescopes into tail rod, 15, at once sealing all communication be-

tween the tail rod and the interior of the piston proper.

As the piston and rods, 14 and 15, are kept filled with oil, it will be apparent that the entire air pressure back of the piston is concentrated upon the column of oil contained in rod, 14, and the passages leading to the punch ram chamber.

The materials used are claimed to be the best obtainable. A special alloy of aluminum is used wherever suitable, thus reducing weight to a minimum.

The Caskey Punch has recently been placed on the market by the Chicago Pneumatic Tool Company, of Chicago, Ill.



CASKEY PNEUMATIC PUNCH.

Further, the volume of oil so moved at each stroke being just sufficient to depress the punch, 36, the proper distance, as soon as hole is punched no further downward motion is possible. It will be clear that all jarring and undue strain on the parts are thus prevented, and a steady yet positive action gained.

When the piston has completed its working stroke a slight turn of the valve, 32, admits the air to the other end of the cylinder, thus equalizing the air pressure on both sides of the piston; but the area of the stationary rod, 14, being less than that of the tail rod, 15, the ball piston is forced back in position for another stroke. A great saving in air consumption is effected by this arrangement, the same air being utilized to drive the piston in both directions.

Owing to the peculiar construction and arrangement of the ball piston and parts coacting therewith, it is impossible for any air to get into the high pressure passages, unless the oil level in piston is permitted to fall below the top of opening in the tail rod, when piston must be refilled at once.

The Arnold Electro-Pneumatic System of Propulsion.

Considerable public attention has been drawn to the electro-pneumatic system of propulsion, planned by Bion J. Arnold, on account of the destruction by fire at Lansing, Mich., of his trial car almost on the eve of an intended demonstration. Mr. Arnold has written to the *Railway and Engineering Review* concerning his invention, and the same paper has also given space to a description of the system. Through the courtesy of the *Railway and Engineering Review* we are enabled to reprint Mr. Arnold's letter and the descriptive article with illustrations. The comments on Mr. Arnold's letter are those of the editor of the *Review*. The letter and description are given herewith.

Editor The Railway and Engineering Review:

As many of your readers know, I have persistently advocated the use of the alternating current directly in the motors for electric railways for several years

(See Transactions American Institute of Electrical Engineers' joint meeting with the British Institution of Electrical Engineers, Paris, August 16, 1900; Niagara Falls convention, August 24, 1901; Great Barrington, Mass., June 19, 1902, and New York, September 26, 1902). By referring to the discussions which took place at these meetings, and to the technical papers, it will be found that there were few, if any other advocates, in this country, of the alternating current motor for railway work, until recently, and that those who supported it abroad advocated the use of three phase currents until within the last few months. Since my announcement of the principles of my system before the Great Barrington convention, the development of the single phase alternating current railway motor has made remarkable strides, both in this country and abroad, and while at that time it had few friends, the development has been such since that it now seems destined to take its place as the leading railway motor, thereby effecting a revolution in electric railway work.

Many of your readers also know that, since announcing the principles of my system before the Great Barrington convention, I have refrained from giving out any further information regarding it, giving as my reasons therefor my desire to test the system thoroughly, before making further public statements regarding it, and then to present a full and complete description of it, together with the results of its operation, in the form of a paper before the American Institute of Electrical Engineers. Consistently pursuing that policy I have conducted my experiments privately and at my own expense, and had so perfected my apparatus that I had hoped to be able to celebrate the incoming of the year 1904, with a public demonstration, over twenty miles of railroad, which would conclusively prove that the single phase electric railway is not only operative but efficient and less in first cost and operation than any system now in vogue, not meaning to imply thereby that the system which I have developed was necessarily the only system or the best system, for only time can prove that correctness or incorrectness of such statements, but that it was a system which would successfully do the work, and the system which was first developed and first to be put in actual operation upon the first electric railway in the world especially built for single phase alternating current motor operation.

That I would have made a demonstration on January 1 was a certainty, to me, until December 18, when I learned by telegraph, while in New York, that the car barns, located at Lansing, Mich., of the road upon which I had been experimenting, were completely consumed by fire at four o'clock that morning. The fire, apparently, originated from a stove in the engine house and was communicated so rapidly to the car barns that it destroyed a steam locomotive and two new cars built for my system, as well as my experimental locomotive, thus leaving me unable to make the demonstration as I had planned. In view of the fact, however, that the single phase electric railway is now receiving so much attention at the hands of engineers and inventors in many parts of the world, and that I believe that the year 1904 will be an epoch-making one, marking the revolution from the direct current to the alternating current motor for railway work, as well as the beginning, on a large scale, of the displacement of the steam locomotive on railways by the use of a substantial form of overhead construction rather than the third rail, and from the further fact that I cannot get another machine ready in the near future, I have concluded that I will give to the technical press a record of my work up to the present time in order that it, and the system which I have developed, may be properly weighed in comparison with the work and systems of others, leaving the more complete description of the system and the results of its operation to be presented at a later date before the American Institute of Electrical Engineers.

On January 10, 1900, I rode over the country between Lansing and St. Louis, Mich., a distance of about sixty miles, with a party of gentlemen who desired to build an electric road between these points. The trip resulted in my advising them that the territory was such that I believed the road should be built as economically as possible, and inasmuch as they desired me to assist financially in its construction I told them I would do so provided I was allowed to construct the road in accordance with certain ideas that I then had in mind, for by such construction the first cost of the road

could be kept sufficiently low to warrant its construction, and that if it were built on any one of the systems, standard at that time, the advisability of building it was questionable. The result was that on April 23, 1900, a contract was entered into wherein I undertook to build and equip the road. Engineers were at once placed in the field to locate it, and after the plans were sufficiently completed, the grading, bridging and track work of twenty miles of the road followed, and this much of the road was completed to such an extent that steam trains were put in regular operation over it about November 15, 1901.

For financial reasons the completion of the road was delayed and in the meantime the development of my system was taking place and the parts being perfected in different offices and shops.

Since it was my intention to experiment with pressure as high as 15,000 volts on the working conductor, all of the line material had to be specially designed, but the work progressed to such an extent that the overhead and line work of 20 miles of road was practically completed and ready for operation about December 15, 1902, and the power installed so that experiments began in March, 1903. On June 15, 1903, two trips were made, each about three miles long, with my first experimental machine. On the first trip seven persons were carried, and on the second trip thirteen persons were aboard.

The result of the experiments with the first motor proved the correctness of the theory and that the machine would work. Inasmuch as it consisted of but one somewhat crude electro-pneumatic motor, it was impracticable to get full and efficient tests of the system, and it was thought best to conduct no further experiments until a complete new double equipped truck be perfected. Not being connected with manufacturing establishments I have been compelled to develop this system under trying circumstances, necessitating the construction of parts in different shops and assembling them at far distant points with crude facilities. This fact, combined with the financial difficulties that have arisen, and the necessity of my having to give the main part of my attention to other matters, have been the causes of the delay in completing the road and the system.

A new double motor equipment in the form of a locomotive was finally built and brought to perfect working condition on the evening of December 17, and it was this locomotive with the necessary instruments for testing purposes that was destroyed by fire the following morning. Since it is going to be impracticable for me to get a new one constructed for some time, I have thought best to state the facts as outlined above, and give to the technical press a description of the apparatus and the road, reluctantly omitting the records of operation and the tests which I had hoped to have accompany any future statements I made, but which through "the irony of fate" must now be left for the future.

I hand you, herewith, a hastily prepared description of the road and the system, which I trust will be found sufficiently comprehensive to interest your readers.

BION J. ARNOLD.

[The description of the road and system of electro-pneumatic propulsion last mentioned in Mr. Arnold's communication is presented in condensed form at another point in these columns, and in connection with the same the reader is referred to the complete illustrated description of the Lansing-St. Johns & St. Louis Ry., which appeared in the issue of the *Railway and Engineering Review* of Feb. 15, 1902. In addition to the above the particulars of the system in question, as set forth in Mr. Arnold's remarks at the Great Barrington convention, were presented on page 509 of our issue of June 28, 1902.—ED.]

Elsewhere in this issue a communication of Mr. Bion J. Arnold is presented, referring to the description which follows of the electro-pneumatic traction system of his invention and the unfortunate burning of the car barn of the Lansing, St. Johns & St. Louis Ry. on the early morning of December 18, by which a completely equipped apparatus ready for final test was destroyed. It was, as stated, the intention to carry out an exhaustive series of tests before making the details public, but in view of the delay now unavoidable, a general description is given at this time and the results of a number of rigid trials will be made known as soon as a newly equipped car or locomotive can be constructed and tested. A complete, illustrated description of the Lansing, St. Johns & St.

Louis road was published in the issue of the *Railway and Engineering Review* for February 15, 1902, and some remarks of Mr. Arnold at the Great Barrington, Mass., convention of the American Institute of Electrical Engineers relative to his system were quoted in our issue of June 28, 1902. The description of the electro-pneumatic system as at present perfected and issued by Mr. Arnold, is abbreviated below, as follows:

ROADBED AND TRACK.

The Lansing, St. Johns & St. Louis Ry. was originally projected to extend

passenger service, and thus secure all the business available from the territory through which it passes.

The road is equipped with 67-lb. T-rail, laid on ties spaced 2 feet apart between centres, and as alternating high tension current was to be used, but one of these rails was bounded with 38-inch 4-0 bonds extending entirely around the splice bars. Since it was impossible to secure rails from the rail manufacturers in time rails and splice bars were secured from one of the leading steam railways, and this necessitated the adoption of a supported joint and a long bond, as there

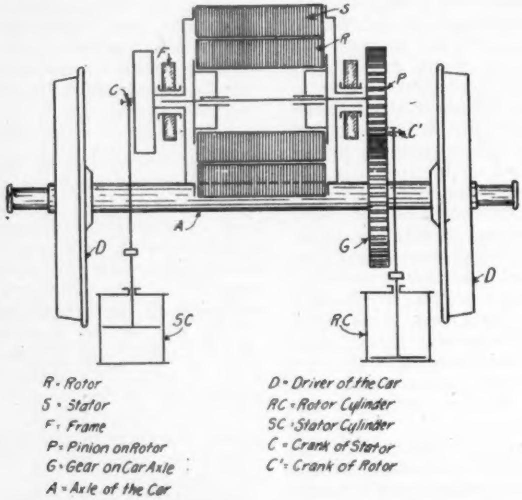


FIG. I.—DIAGRAMMATICAL REPRESENTATION OF WORKING PARTS, ARNOLD ELECTRO-PNEUMATIC MOTOR.

from Lansing, northward through St. Johns and Alma to St. Louis, Mich., a distance of about sixty miles, but up to the present time only that portion extending from Lansing to St. Johns, a distance of twenty miles, has been constructed. This road was built in accordance with steam railroad practice, with easy grades and curves, so that steam locomotives could be operated over it until such time as electrical equipment could be put upon it; the idea being to complete the road in such a manner that it could be utilized for both freight and

was not room under the splice bars for concealed bonds.

The road as at present constructed between Lansing and St. Johns has no grades exceeding 1 per cent. and no curves exceeding 7 degrees, except in the cities themselves, where the terminals of the road run over the streets and make such curves as ordinary street cars make, the minimum radius being 50 feet. At each city a terminal was planned so that all freight would be diverted to connecting steam roads, thus making it unnecessary for the freight service to pass over the

city streets or curves. At the Lansing end it was necessary to pass over the steam railway tracks of the Pere Marquette R. R., and this necessitated the construction of a bridge, with pile approaches; the grade as approached from the Lansing end being 4 per cent. for a distance of about 700 feet, and after passing over the bridge the descending grade is 2.3 per cent. for about 500 feet. At the St. Johns end there is a grade on the principal street of the town averaging about 2 per cent. for about 1,500 feet.

OVERHEAD CONSTRUCTION.

Considerable care was taken in planning a suitable insulator for carrying the trolley wire, one of annealing glass being used, and in the ordinary arrangement of the straight-line overhead construction wood is used for the pole, cross arm and brace, and the insulator is supported by means of a short span wire from iron brackets secured to the wooden cross arm. This construction insured a high insulation at a low first cost, the entire line having been constructed for but a slightly increased expense of the cost of standard construction, and at the same time so built that in case of failure of the alternating motor system the standard direct current motor system could be put into service without changing any parts. The working conductor was placed 22 feet above the top of the rails in order that train men when standing upon the tops of the freight cars going over the road could not come in contact with the working conductor.

The power house is located at one end of the line, owing to the electric company, from which power is purchased by the railroad, having a water power at this point. Current is transmitted to the nearest end of the line over two No. 3 wires. The power is furnished from a 300 K. W. rotary converter generating at 380 volts, at 25 cycles, the energy from which is stepped up to the working pressure of the line (6,000 to 10,000 volts). It was the intention, after experimenting a sufficient length of time to determine the best voltage for the working conductor, to have the generators for the permanent plant constructed so as to generate at this determined voltage, and it was for this reason that a temporary rotary converter was first installed to conduct the experiments with.

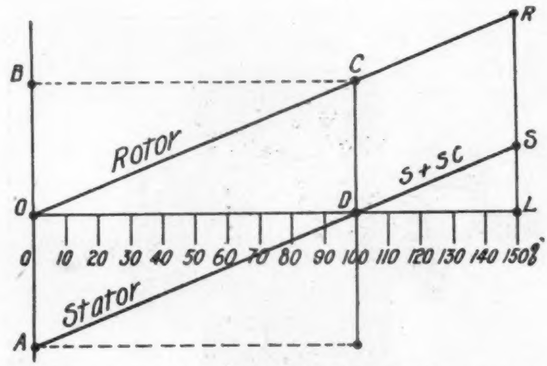


FIG. 2. —SPEED DIAGRAM, ARNOLD ELECTRO-PNEUMATIC RAILWAY SYSTEM.

In order to explain clearly the principles on which the system is based, the statements made by Mr. Arnold before the Great Barrington convention on June 19, 1902, are again reproduced as follows:

"The principles underlying the system I advocate and which I call an electro-pneumatic system, are as follows:

1. "A single-phase or multiphase motor, mounted directly upon the car, designed for the average power required by the car, and running continuously at a constant speed and a constant load, and, therefore, at maximum efficiency.

2. "Instead of stopping and starting this motor and dissipating the energy through resistances, as is customary with all other systems known to me, I control the speed of the car by retarding or ac-

celerating the parts usually known as the rotor and stator of the motor, by means of compressed air, in such a manner that I save a portion of the energy which is ordinarily dissipated through resistances, and store it to assist in starting the car, helping over grades, for use in switching purposes, and for the operation of the brakes.

3. "By this method of control I secure an infinite number of speeds, from zero to the maximum speed of the car, which may or may not be at the synchronous speed of the motor, for with the air controlling mechanism working compressing, the speeds below synchronism are maintained, and by reversing the direction of the air through the controller speeds above synchronism may be attained for reasonable distances. This feature gives to the alternating current motor the element absolutely essential for practical railway work, for it permits a car or train to ascend a grade at any speed with the motor working at its maximum efficiency and imparting its full torque to the car. When descending the grade the motor may utilize its full power drawn from the line in compressing air, or it may be used to compress air with the stored energy of the train, thereby acting as a brake.

4. "By virtue of the air storage feature, each car becomes an independent unit and capable, in case of loss of current from the line of running a reasonable distance without contact with the working conductor. This feature will enable a car to work on a high tension trolley wire or active conductor over private right of way, and allow the active conductor to be stopped where the private right of way ceases, and the car to proceed through a city or town on any tracks, whether electrically equipped or not, until it reaches the outskirts of the city or town where it can take up the working conductor again on private right of way. This feature is also valuable in switching work, for each car being independent it can leave the main line track and operate over switches or sidings without complicating the yards with additional overhead or third rail conductors, thus necessitating through line conductors over main line track or tracks only.

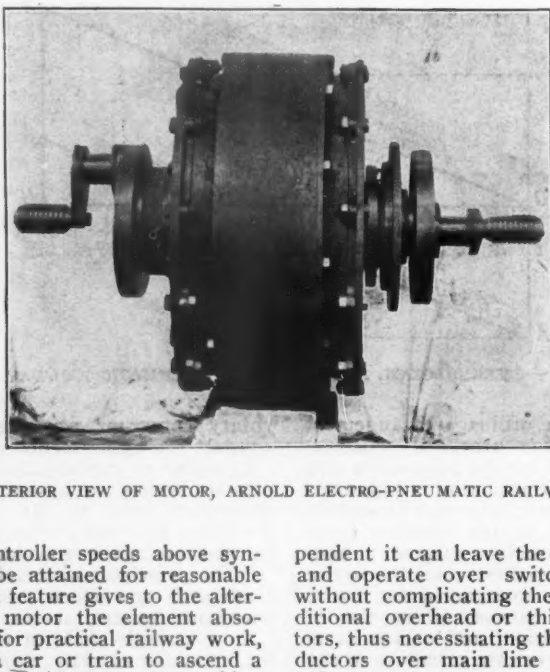


FIG. 3.—EXTERIOR VIEW OF MOTOR, ARNOLD ELECTRO-PNEUMATIC RAILWAY SYSTEM.

5. "Since a single-phase motor can be used the motors can be supplied with current from a single overhead wire or third rail, and with a single rail return circuit, thus permitting the overhead construction, or third rail construction, to conform to the standard of to-day, except that a much higher working voltage

can be used, provided the insulation is taken care of. Furthermore, in steam railway work this system, by virtue of its single-phase feature, will only require the use of one of the track rails for the return circuit, thus leaving the other rail for the use of the signal system, which, up to the present time, does not seem to have been satisfactorily solved without the use of one of the track rails.

6. "The current will be taken from the working conductor at any voltage up to the limit of the insulation, and in case this voltage is high (I am building my line for 15,000 volts), a static transformer will be carried upon each car and the pressure reduced from the line voltage to the voltage of the motor, which in the case under construction is designed for 200 volts. Where it is unnecessary to utilize so high a line pressure the motor may be designed for the working voltage, and the current fed directly from the working conductor into the motor, thus eliminating the static transformer. When a high voltage working conductor and static transformer is used, and it is thought advisable to use a working conductor through cities and towns, this working conductor will be supplied with energy through a stationary transformer at each city limit, thus making the working conductor through the cities or towns safe.

7. "By virtue of the speed of the motor and its constant load, either when the car is in motion or when it is standing still, and the motor is compressing air, the variable load now customary in electric railway power plants is eliminated, and the power station works at practically a constant load, thereby eliminating a large part of the investment at present requisite in power station and line construction. Furthermore, by virtue of the air storage feature, each car, in the particular apparatus I have designed, is capable at any time when current is on the working conductor, of delivering to the car wheels a much greater torque in proportion to the capacity of the motor than is possible with any electrical system known to-day.

"I believe that by the adoption of this system the following results will be accomplished:

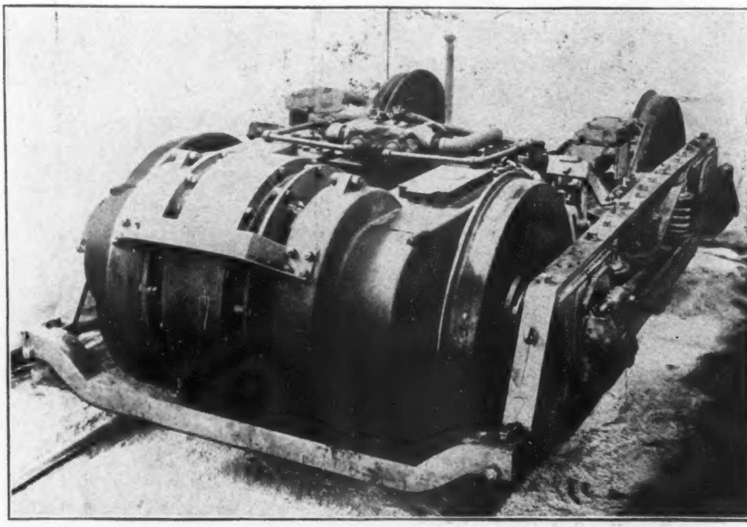


FIG. 4.—FORWARD VIEW, FIRST EXPERIMENTAL MOTOR AND TRUCK

1. "The entire elimination of the present standard system of rotary converter sub-station plant, together with the maintenance thereon, and the cost of the necessary attendants.

2. "The absorbing and rendering available for useful work in starting, or otherwise, a large percentage of the energy stored in the moving mass which under the present methods of operation is dissipated at the brake shoes.

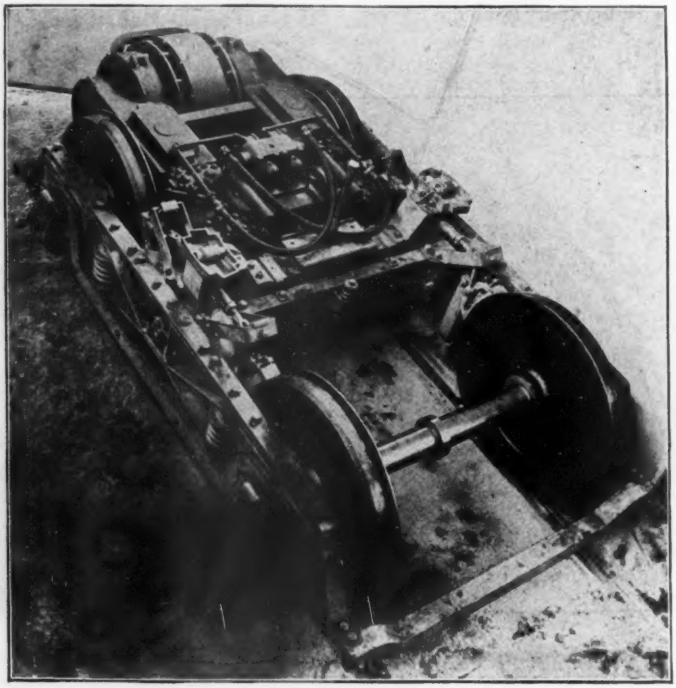


FIG. 5.—REAR VIEW, FIRST EXPERIMENTAL MOTOR AND TRUCK.

3. "A large reduction in the first cost of electrically equipped long distance railroads, thereby making it feasible, from an engineering and business standpoint, to equip many roads which cannot now be shown advisable, thus opening up the steam railway field to the industry in which we are now engaged".

The following description, together with the accompanying illustrations, will set forth more in detail the application of the principles of the system and the mechanism of its working parts:

Figure 1 represents diagramatically the working parts of one form of the system: The rotor, *R*, of a single-phase induction motor is geared to the axle of the car and by means of crank pin, *C*, secured in pinion, *P*, also drives the compressor cylinder, *R C*, while stator, *S*, can freely revolve around the rotor and drive by means of a crank pin, *C*, the compressor cylinder, *S C*. Both cylinders are piped to air reservoirs located under the car and are also provided with suitable valves manipulated from a single controller on the car platform for making them perform their various functions, thus the entire regulation of the speed and power of the car is controlled by the air cylinder and no other regulating devices are necessary. The cylinder valves are electrically operated which makes it possi-

ble for each cylinder when driven by the electric motor to compress air into the tanks, and when operated by compressed air to furnish mechanical energy for moving the car. When, for instance, the cylinder is compressing air the valves work like inlet and outlet poppet valves of a common air pump, while on the other hand if the cylinders are supplied with compressed air each valve is operated electrically by a pilot solenoid connected with the valve seat in such a manner that the energy for moving the valve is supplied by the compressed air, thereby making the valve practically self-actuating. The time of operation of the valve is controlled by a series of collector rings revolving with the engine shaft, and their regular operation is interrupted and varied to suit the requirements by means of the motorman's controller.

When a rotary or turbine type of air engine is used all of the above valves and reciprocating parts are eliminated and the entire controlling mechanism consists of two air valves operated from a single engineer's valve, which may be located upon the platform of the car or in the cab of the locomotive, and so arranged that one or more units may be operated from the platform or cab of any unit without the necessity of connecting wires between the units.

Since the motor may be of the simplest type of induction motor without a commutator, and the system does not require the manipulation or breaking of the main current, the motor may be designed for any working voltage and be of any type which will maintain a constant speed when provided with a constant load. This eliminates the necessity of all step-down transformers, resistances or other regulating devices and confines the current to the motors themselves, and as these are below the car floor the danger from the current is reduced to the minimum.

At the same time the air cylinders, in addition to performing all the functions of speed control, give to the machine the independent unit element, and the ability to store the kinetic energy of the train in stopping and utilize it in starting. On account of these and other features the

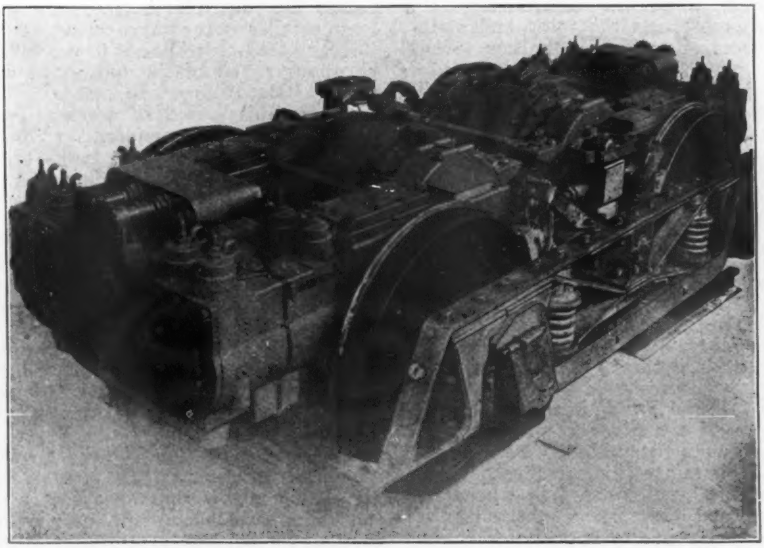


FIG. 6.—GENERAL VIEW, LATEST FORM OF TRUCK AND MOTOR.

electric motors of this system can be much smaller in capacity, when rated as continuous working motors, than those of other systems not possessing this equalizing load feature, and the capacity of the power house and line can be reduced to about one-half of what would be required with systems where the fluctuating starting loads of the cars are transmitted back to the power house.

In order to better understand the different operations of the system, Figure 2, showing a speed diagram, has been prepared in which, on the axis of abscissa, *O D L*, are represented the different car speeds in per cent. of the synchronous motor speed, while the co-ordinate axis, *A O B*, represents the rotor and stator speeds corresponding to the car speeds shown.

The operation of the car may be divided into the following periods:

1. Standing in the Station—Referring to Figure 1, the rotor, *R*, is standing still, while the stator, *S*, runs with full synchronous speed. The stator is then transferring the full energy of the electric motor through crank, *C*, to the compressor cylinder, *S C*, which energy is being delivered in form of compressed air into the air reservoir. Since the relative velocity between the stator and the rotor is, under all conditions of operation, constant, the speed curves of stator and rotor may be represented by two parallel lines, *O C R* and *A D S*, in Figure 2. The origin, *O*, of the given co-ordinate system represents the period of rest of the car, and therefore, indicates zero rotor speed and full stator speed in a negative or downward direction, as the stator is now revolving in the opposite direction from that which the rotor must revolve to drive the car forward.

Let it be further assumed that for an instant *O A* equals the active torque of the stator, then it will be easily understood that *O B*, which equals *O A*, represents the reactive torque of the rotor exerted on the car axle, meaning that if the car is free to move the reactive torque can be used advantageously for the starting and acceleration of the car.

When the car is standing in a station it is held at rest by moving the controller to such a position that the outlet pipe from rotor cylinder, *I C*, is throttled, thereby increasing the pressure behind the piston to such an extent that it overcomes the effect of the rotor, *R*, to revolve, thus tending to cause the stator, *S*, to revolve and at the same time holds the car at rest without the use of wheel brakes.

2. Starting and Accelerating.—To start the car the air cushion behind the piston of *R C is* removed and the air which is being compressed by cylinder, *S C*, supplemented by the stored air from the tanks, is admitted to the cylinder, *R C*, with the controller at the position of maximum cut-off. The rotor then begins to revolve, and as it accelerates the stator slows down by exactly the same amount that the rotor has increased its speed, and as the rotor and car speed increase the controller is gradually moved to a smaller percentage of cut-off until the car speed corresponds to the full synchronous speed of the motor, at which time the stator comes to rest.

During this period of acceleration the air compressed by cylinder, *S C*, instead of being delivered to the tanks to lose its heat, is delivered, hot, directly to the rotor cylinders, thus greatly increasing the efficiency of the combination, as the heat usually lost in air systems is utilized and the advantages of heated air gained without a reheater, and as the pressure used is low many of the ordinary difficulties in the use of compressed air disappear. If the rate of acceleration is such that cylinder, *R C*, uses all of the air supplied by cylinder, *S C*, no exhaust to the atmosphere from cylinder, *R C*, takes place.

Referring now to Figure 2, which graphically represents this process, since the electric motor runs always at a constant speed and a constant load, it has a constant torque, and therefore the distance between lines *O C R* and *A D S* may be considered as representing the energy delivered by the electric motor. The length of any ordinate extending from *O D* to *O C* represents the proportionate amount of energy derived from the electric motor which is applied directly through pinion, *P*, and gear, *G*, of Figure 1 to the propulsion of the car, while the corresponding ordinate extending below *O D* to *A D* represents the proportionate amount of the energy of the electric motor which is absorbed in compressing air through cylinder, *S C*, which energy, in the form of air, is immediately transferred to cylinder, *R C*, and is utilized in accelerating the car.

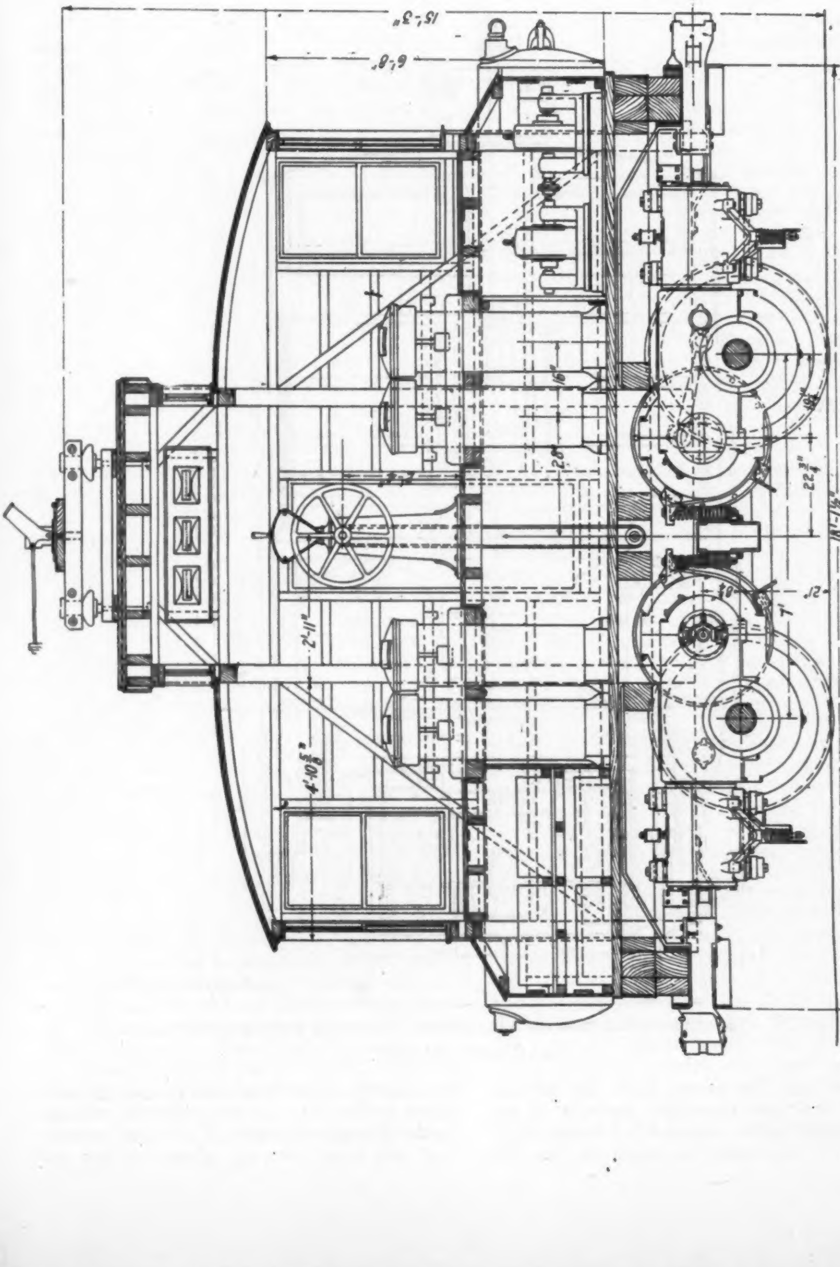


FIG. 7.—LONGITUDINAL SECTION OF LOCOMOTIVE—ARNOLD ELECTRO-PNEUMATIC RAILWAY SYSTEM.

In practice, however, since there will be a loss in transferring the energy from electrical energy into energy in the form of compressed air and back again into mechanical energy, this loss, whatever it power of the electric motor upon the car axle during the period of acceleration. Should it be desired to accelerate at a greater rate than the full power of the electric motor is capable of giving to

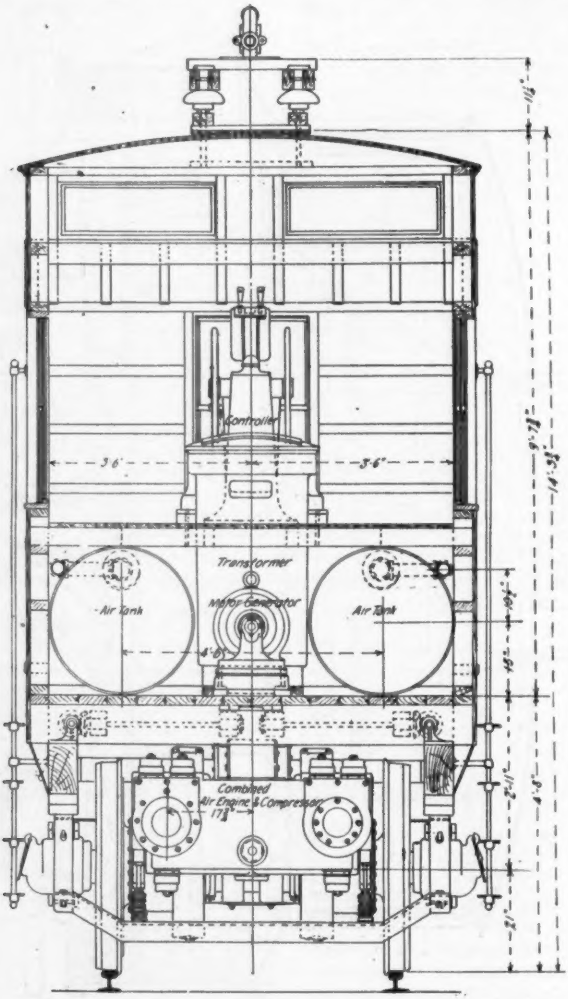


FIG. 8.—TRANSVERSE SECTION OF LOCOMOTIVE—ARNOLD ELECTRO-PNEUMATIC RAILWAY SYSTEM.

may be, must be drawn from the storage tanks, and the requisite amount of air from these tanks supplied to rotor cylinder, *R C*, in order to maintain the full the car the additional energy may be supplied in the form of air from the storage tanks through cylinder, *R C*, thus increasing the total energy given to the car

during acceleration, in which case this total power would be represented for any given instant by a point above line, *B C*.

3. Full Speed.—When the rotor has reached full synchronous speed by the previous operation, this speed can be maintained by moving the controller to another position, which will throttle the outlet pipe of cylinder, *S C*, until the reaction due to the pressure behind the piston equals the full capacity of the electric motor. An overload or underload may be placed upon the motor by varying this pressure, but under normal conditions of operation cylinder, *S C*, is provided with an automatic valve which keeps a constant pressure behind its piston thus maintaining an absolutely constant load upon the electric motor and consequently a uniform demand of electrical energy from the line. This uniform load is represented by the parallel lines, *O C R* and *A D S*, of Figure 2.

With the controller set at full speed position the inlet valves of rotor cylinder, *R C*, are held open and the piston runs free and the electric motor now gives its full power to the car axle, and the stator and its air mechanism will remain at rest as long as the car runs at the speed corresponding to the synchronous speed of the motor.

4. Speed Variations.—There are usually certain places on any road where high rates of speed can be maintained for short distances, and as these speeds might be higher than the synchronous speed for which the motor was designed they are provided for as follows:

Assuming that the car is running at synchronous speed, the controller may be moved to such a position that the valves of stator cylinder, *S C*, operate in such a manner as to cause it to act as an engine and revolve stator, *S*, in the same direction as rotor, *R*, is revolving. This now causes, owing to the constantly electrically maintained relative difference in speed between the stator and the rotor, an increase of speed of the rotor and car axle, due to the motor automatically working as a magnetic clutch, without mechanical contact, and if the resistance of the car or train is less than the capacity of the electric motor the air necessary for revolving the stator can be obtained, hot, from the rotor cylinder, *R C*, without drawing from the tanks, and a speed above synchronism indirectly proportional to the resistance of the train maintained indefinitely. When the resistance of the train is greater than the capacity of the electric motor speeds above synchronism can be obtained only by supplying rotor cylinder, *R C*, with stored air from the tanks and can only be maintained for short distances, or until the storage capacity of the air reservoirs is exhausted. This condition corresponds to the spurts that can be made by a steam locomotive when working above the steaming capacity of the boiler. The distance from the line, *O D L*, to that portion of the line, *A D S*, above *O D L*, in Figure 2, represents, at any given speed, the proportionate amount of energy which must come from the tanks and be supplied through cylinder, *S C*, and the distance from *D L* to *C R* represents the total energy given to the car by the combined action of the electric motor and the stator cylinder when operating under these conditions. The energy delivered to the car can be still further increased by admitting air into rotor cylinder, *R C*, and allowing it to work as an engine.

5. Retardation.—To bring the car or train to rest, instead of applying mechanical brakes to the wheels in the ordinary manner and thereby dissipating the entire stored energy of the car or train in the form of heat, this energy is saved in the form of compressed air, to assist in starting the car or train, by setting the controller in such a position that rotor cylinder, *R C*, compresses air and delivers it into the storage tanks. Any desired rate of retardation can be secured by throttling the delivery pipes from rotor cylinder, *R C*, and in practice this pipe is provided with an automatic valve which releases just before the slipping point of the wheels, thus allowing the motorman to brake as rapidly as he desires without liability of flattening the wheels. Supplemental wheel brakes are provided for emergency, but need not often be used, and the ordinary wear and tear on them is saved. When the car is again at rest the cycle of performance as above given is repeated for the next run.

6. Reversing.—When it is desired to run the car backward for short distances the electric motor is not disturbed and the power is furnished by the rotor cylinder, *R C*, by reversing the action of the valves, but if it is desired to run backward for any great distance the current is thrown off the motor, the stator engine

reversed, and the stator brought to speed by the air, when the current is again thrown onto the motor, and the cycle of operation is the same as when running forward.

Figure 3 represents the exterior of the electric motor, showing the cranks of the stator and rotor, also collector rings for operating the valves of the air cylinders when working as engines. Figures 4 and 5 show, mounted upon a truck, two views of the first electro-pneumatic motor constructed, and upon which the first experiments were conducted. The single motor represented in Figures 4 and 5 was too small in capacity to propel a large car and it was decided to experiment with an improvised locomotive, consisting of the truck and motor shown, carrying suitable air tanks and transformers upon a temporary frame structure, and this locomotive was the one upon which the trial runs were made and passengers carried on June 15, 1902. Figure 6 shows a general view of the new electro-pneumatic motor constructed after the preliminary experiments had been made on the first motor. For experimental purposes this truck was fitted up in the form of a locomotive as shown in longitudinal and transverse section by Figures 7 and 8. and it was this locomotive that was recently destroyed by fire. In order that the locomotive might operate as an independent air unit upon tracks not equipped with overhead electrical conductor it was provided with a small storage battery and small motor-generator for charging the batteries and for operating the headlight. These auxiliaries are not necessary for the successful operation of the system, provided the locomotive can always be supplied with electric current from the working conductor, for then the valves can be made to operate from alternating current and thus eliminate the use of motor-generator and batteries. When, however, it is desired to operate independently of the electric conductor these auxiliaries are necessary, and one set may supply an entire train. It will be seen that the locomotive is also provided with transformers, another auxiliary which is unnecessary in case the motors are designed for the voltage transmitted over the working conductor, but in this case transformers were used because the manufacturer of the motors could not be induced at the time they were purchased to build a high-tension motor for railway work, consequently the parts of a standard motor were utilized and a pressure of 200 volts adopted for the motors, as this was the most economical voltage that could be used with the particular parts selected. This locomotive was provided with all necessary testing instruments, and had been operated in the barns for some time and found to perform all its functions successfully, and would have been placed on the road and experiments with it would now be in process had it not been destroyed.

Hocking Valley R. R. Instruction Car.*

In keeping with the spirit of progress, the Hocking Valley Railroad has recently built at their shops in Columbus, O., from designs made by Mr. S. S. Stiffey, superintendent of motive power, an elaborate, up-to-date instruction car, which contains all the apparatus necessary to demonstrate thoroughly the workings of the air brakes, steam heat, injectors, lubricators and other attachments usually found in modern railway service, and it is to be used for the purpose of instructing the employees of this system in the correct method of caring for, operating and maintaining these devices.

In the accompanying illustrations of the car, view No. 1 shows the exterior. View No. 2 shows the interior, looking toward the office and reception room. The brakes are operated by the engineer's brake valves, either Westinghouse or New York, as desired, both of these types of brakes being used on this system, and they are shown located in the end of the car, mounted on the main reservoir. The freight brakes, 18 in all, consisting of 9 Westinghouse and 9 New York equipments, are located on one side of the car, while the passenger brakes, consisting of engine, tender and passenger coach equipment, are located on the other, thus leaving a large space between the equipments in the center of the car for the accommodation of the classes.

The brake valves are so piped that the apparatus may be operated by either the Westinghouse or the New York, by simply cutting out one or the other. To each engineer's valve there is a sectional valve

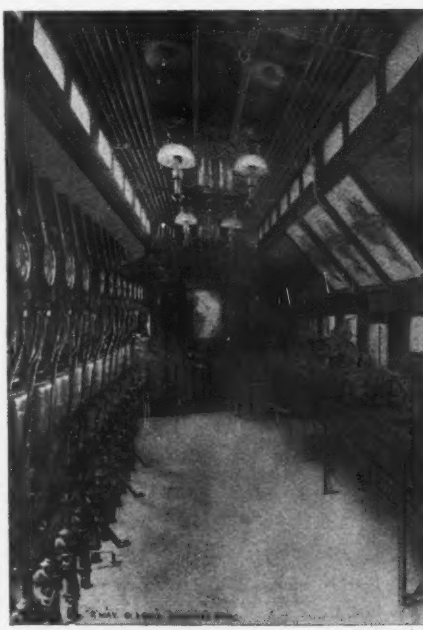
*By F. M. Nellis, in the Air Brake Department, *Railway and Locomotive Engineering*. Illustrations given through the courtesy of that publication.

NO. I.—EXTERIOR VIEW OF THE HOCKING VALLEY AIR-BRAKE INSTRUCTION CAR.

of the same type, connected in tandem, so that the student can see just what each valve is doing in each position of the handle. The triple valves also have sectional models working in tandem with them, so that their operation may be easily seen and understood. Sectional parts of all air brake valves, steam valves and lubricators used on the system, are conveniently located in different parts of the car, where they may be examined and their construction studied.

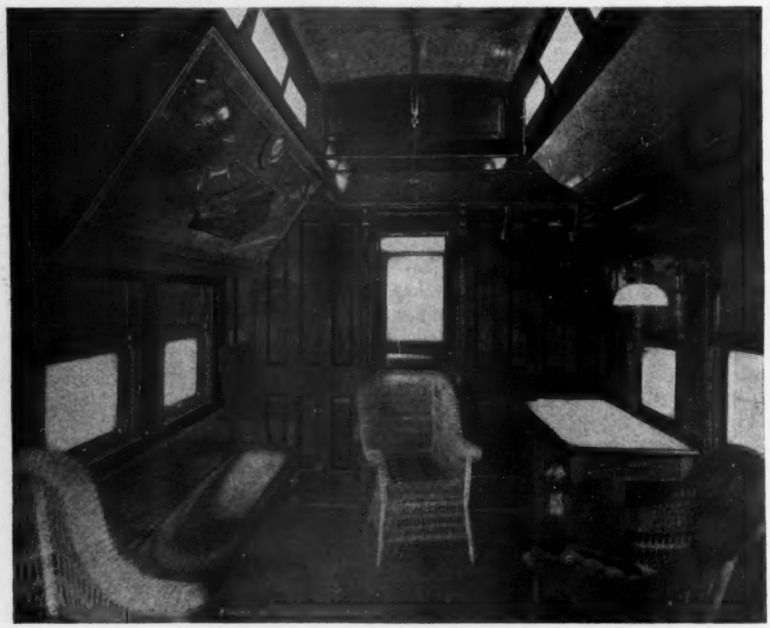
Five large charts of the New York quick action triple valve, showing its different positions while in action, adorn the sides of the car, and are hung just above the passenger equipment. The train air signal piping is attached to the roof, where it may be conveniently operated and yet not be in the way.

View No. 3 shows the interior of the car, looking toward the other end, in which the Fairbanks and Morse air compressor, which furnishes the compressed air to operate the brakes, is located. A gasoline engine operates the compressor, so that there is no necessity for a boiler or a coal and water storage. View No. 4 shows the office and instructor's room, with upper and lower berths for the accommodation of those in charge.



NO. 2.—AN INTERIOR VIEW OF THE HOCKING VALLEY AIR-BRAKE INSTRUCTION CAR.

NO. 3.—INTERIOR VIEW OF THE HOCKING VALLEY AIR-BRAKE INSTRUCTION CAR, LOOKING DOWN THE AISLE WAY TOWARD THE COMPRESSOR.



NO. 4.—THE OFFICE AND SLEEPING ROOM OF THE HOCKING VALLEY AIR-BRAKE INSTRUCTION CAR.

The piping for the brakes is the same in length as that found on an ordinary train of 18 cars, and is so arranged that all angle cocks and cut-out cocks may be conveniently manipulated in the same manner that it is done in actual service on the road, and the whole or any desired part of the brakes operated at will. By this means all the peculiar operations of the brakes, due to cutting in cars with defective triples, or cutting them out, as well as the effect produced at the brake valve on the train pipe exhaust by different lengths of train pipe may be shown. The whole interior arrangement of the apparatus is convenient and compact, utilizing all available space in such manner as best to serve the purpose for which the car is intended, which reflects much credit on the ability of the designer.

The car is in charge of Mr. L. C. Engler, general road foreman of engines, who is assisted by Mr. H. H. Hill, assistant road foreman of engines, and Mr. W. H. Wiley, traveling fireman. The car will be kept in operation all the time over the 1,100 miles of road owned and operated by the Hocking Valley Company, and will on those lines, as similar cars have done on other lines, prove a great benefit to the employees, and a paying investment to the company.

Notes.

The American Pneumatic Cushion Company, of New York, has been incorporated with a capital of $5,000. The incorporators are Chas. B. F. Burton, Taylor S. Buck and H. Hoellis.

The Thompson Air Compressor Company, of New York, has been incorporated with a capital of $50,000. The incorporators are Chas. O. Thompson, H. M. Seely and Wm. M. Stockbridge.

In cleaning up after the great fire which recently devastated the business section of Baltimore, Md., compressed air promises to be found of much service for cleaning bricks. The air blast has already been proven successful in that respect.

Assistant Chief Thos. Haines, of the St. Louis Fire Department, has invented a combined aerial ladder and water tower which is said to be one of the most practical in existence. This water tower may be raised by means of compressed air or by a single screw.

Pneumatic sweepers have been tried with success in the city of Indianapolis, Ind. As soon as the snow disappears these machines will be put at work by the Indianapolis Street Cleaning Company, which is operated under the direction of the Board of Works.

The patent war, which has of late so excited the automobile trade in this country, is over the Seldon patent, which was taken out in the United States in 1879, which was for a motor car driven by compressed air. It is not certain, however, whether this vehicle was ever constructed.

The attention of readers of COMPRESSED AIR is called to the fact that our supply of copies of COMPRESSED AIR for November, 1902, is exhausted, and that we still have a demand for them for binding. We shall be glad to pay the regular price for any copies of that issue which are sent to this office.

Among the recent inventions patented in England is a device by W. O. Wood and J. H. Miller, both of South Hetton, Durham, Eng., for mining machines of the chain cutter type. The machine is pushed or pulled in any direction by a pneumatic cylinder, provided with a valve or disconnectable hose to supply air to the pressure end.

Compressed air is being utilized by physicians in the care of all diseases of the air passages such as catarrh, bronchitis, tuberculosis, hay fever, asthma, etc. By means of compressed air and a series of tubes the various ingredients which are used in treating these diseases and to destroy the germs are brought into direct contact with the affected parts.

F. C. Weber, a mining engineer of Pittsburg, Pa., has devised a system which he believes will be of great importance in preventing mining disasters. His plan is simply a system of surface piping attached to air compressors which will supply sufficient air for entombed miners, and at the same time provide a

means of exhaust for deadly gases. Mr. Weber has applied for patents covering this plan.

J. A. Sangster, of the St. Clair Engineering Works, Aberdeen, Scotland, has constructed a pneumatic surfacing machine, the first one of these supplied to the granite trade by an English manufacturer. A recent test of it is said to have been very satisfactory. The machine is operated by one man and can, it is claimed, level, ready for polishing, about 10 square feet per hour.

The ratification of the canal treaty with the new republic of Panama is of interest to all manufacturers of compressed air machinery. There is no doubt that the difficulties presented in the building of that canal will result in the adoption of compressed air for many duties. Rock drills and channeling machines will play an important feature wherever there is any rock excavation to be made.

The Taissey Pneumatic Service Company, of Indianapolis, Ind., has been reorganized and the capital stock increased to $100,000. The following officers have been elected: President, F. H. Cooper, one of the founders of Siegel, Cooper & Co.; vice-president, C. A. Lockhart, of Buffalo; secretary, Thos. Bemis, of Indianapolis, and treasurer, Major Collins, of Indianapolis. The Taissey pneumatic tube service is used in a number of department stores.

The Eastern Railway of France has adopted a car heating system in which a mixture of steam and compressed air was used. It was found that by admitting a limited amount of compressed air the rate of flow of the steam was increased sufficiently to keep any water of condensation moving constantly toward the discharge end. It is also claimed that this new system makes it possible to heat long trains more rapidly and to make traps operate with greater certainty.

Some idea of the value of compressed air for mining operations can be obtained from a report of the results secured by Meister Bros. in their mines in Kirkwood, W. Va. By the use of an air compressor and a compressed air coal cutter, it is said the operators are now able to mine about 80 tons daily, an output of over 60 tons more than was formerly mined. The operating force has been reduced from 25 to 8 men. It is reported that the machine will cut three rooms 28 feet wide daily and does the work requiring the hand labor of 28 men.

Since the great fire at Baltimore, Md., the authorities of the city of New York have been discussing various plans to prevent such a conflagration in the latter city. One plan recommended is a salt water pumping system which will prevent the possibility of a shortage in the water supply. The power recommended to operate the pumps is a battery of gas engines using illuminating gas from the street mains. To start these engines compressed air at a pressure of 200 pounds to the square inch will be used. This application will, it is claimed, make it possible to start the engines at a moment's warning.

The Medina Quarry Company, with quarries at Albion, N. Y., has just installed a compressor plant to operate rock drills and stone cutting tools. This concern has seen the economies resulting from compressed air installations and has determined to take advantage of them. The compressor installed was built by the Ingersoll-Sergeant Drill Company and is of the Class "H" type, with simple steam cylinders 12 inches in diameter, air cylinders 18¼ inches and 12¼ inches in diameter, and 12-inch stroke. This company has just issued an artistic booklet illustrating the use of its stone in many prominent buildings of New York State.

The Illinois Pneumatic Power Company is reported to be negotiating for the purchase of a tract of land near Chicago, on which it plans to build an elaborate plant. The intention of this company, as outlined by one of its officials, is to utilize power obtained from windmills in making liquid air, liquid oxygen, ice and compressed air. Sheds are to be built which it is claimed will be kept so cold with the manufacture of liquid air that ice can be made in them by simply carrying water inside. Its official fur-

ther states that the company intends eventually to extend a system of piping through the city of Chicago to furnish compressed air.

The mechanical method of handling ores by the Muffly process is placing the ore in a revolving cylinder, which agitates by lifting up at the sides and dropping back over the centre. Cyanide is injected into the cylinder in the form of spray, by means of compressed air, the current of air picking up the cyanide just before entering the cylinder. The air current passes through a heater en route, by means of which the temperature is regulated to suit conditions of extraction. The pulp lifted up by the revolving cylinder falls down through this spray as it discharges. The inventors claim that this method of introducing air and the solution "provides a more effectual and economical supply of oxygen to replace that element rapidly as it separates from the cyanogen compound to enter into new molecular combination with gold, silver and potassium.—*Pacific Coast Miner.*

A steam or compressed air motor will, if its efficiency makes good the claims of its inventor, Peter Thornley, of Burton-upon-Trent, enable express and railway engines to run twice the present speed at only half the cost, or of Atlantic liners to cross from Liverpool to New York in three days.

Thornley has devised a valve which will admit a given quantity of steam every commencement of the stroke, and which is so nicely adjusted that the expansive force of the steam admitted is just sufficient to drive the piston at the end of its journey. It is actually claimed that one ton of coal will produce as much power as eight tons with the existing types.

In even the best railway locomotives the steam is admitted after the piston has moved from five inches to eight inches along the cylinder, thus forming a vacuum of several hundred cubic inches in extent to be filled up before an ounce of power is exerted.—*American Inventor.*

The Treadwell Mines of Douglas Island, Alaska, were described in a paper presented by R. A. Kenzie, at a recent meeting of the American Institute of Mining Engineers. Regarding machine drilling at these mines, Mr. Kenzie says that over 75 of the ore mined from the Treadwell has come from the open or surface pits where machine drilling is seen at its best. The 3½-inch diameter Ingersoll-Sergeant drills set on tripods are used in all the pits at present. The average number of feet drilled per machine in 10 hours is 36.35. The holes are drilled to an average depth of 12 feet and each machine will break 69.69 tons of ore per shift of 10 hours. When the pits were smaller and the difficulty of setting the drills was not so great as at present the average number of feet drilled was much higher and the breaking capacity of machine drill was from 150 to 200 tons of ore per shift of 10 hours. The veins are worked by drilling and blasting the ore from a series of terraces around the chute raised as a centre.

The North-Eastern Railway will adopt the Westinghouse system of electro-pneumatic power signals at the New Paragon station at Hull, England. The proposed installation will be the largest in the kingdom, and will be the record instance in which power signalling has been applied to the working of passenger traffic, a smaller plant having been put into working at Bolton on the Lancashire and Yorkshire in September last. The plant at Hull will comprise two cabins, one fitted with 179 levers and the other with 153. The former will be placed at the entrance to the station and the other about 100 yards to the west of the present Park street box. They will control all the signals and points for four incoming and three outgoing main lines, and all the train movements at the new station, which is to consist of 14 platforms. The work will be taken in hand at once and will proceed simultaneously with the work of building the station. It is hoped that some of the signals will be in operation at the end of the year, though the complete installation will probably not be ready till two years hence.

For some years it has been evident that, by the substitution of either electrical or pneumatic power for the mere hand labor of the signalman, a complete

revolution would be effected in the mode of working railway signals and points. At the present moment there are three distinct systems of power signalling engaging the attention of British railway managers: (1) The all-electric, (2) the electro-pneumatic, and (3) the purely pneumatic. The North-Eastern Railway Company have already adopted installations of the two first-named systems at Severus Junction, York, Green Lanes, and at Tyne Dock, respectively, and, in order to decide the relative merits of the three systems, are now arranging for an installation of the low-pressure pneumatic signalling. The Great Central Railway Company, who have recently decided upon the installation of the "Millar" system of signalling through the Woodhead Tunnel, have, we learn, now also placed an important contract with the British Pneumatic Signalling Company for an installation, in the neighborhood of Manchester, of pneumatic signalling on the low-pressure system. This plant will extend over a very large area, and will be the largest power-signalling installation in this country, and second only to that now in operation at the South Terminal Station at Boston. The Caledonian Railway Company have also decided upon the adoption, experimentally, of Taylor's electrical-signalling system, in order to test this method of working before finally deciding upon the system to be used at their new central station at Glasgow.—*Tramway World* (Eng.).

A new motor has been recently patented by Mr. Peter Thornley, a Burton engineer, an invention, it is claimed, of such importance that its development may result, for example, in doubling the present speed of express railway engines.

Mr. Thornley claims that his new methods of valve gear solve the problem which has exercised the minds of thousands of people. The great importance of the invention centres in getting the steam into the cylinder at exactly the point which is the commencement of the stroke. This effects a saving of at least 25 per cent. of power, and, of course, a proportionate saving all round. As a reciprocating engine it can be run at a much higher rate of speed than has hitherto been accomplished. The ingenious mechanism of the valve gear allows for this. It is simplicity itself, and the engine can be worked under the highest possible pressure. There is also a remarkable saving of nearly 50 per cent. in weight and space. The engines can be fixed in a series of twelve or even twenty cylinders and cranks, all working in unison and controlled by one lever. The lubricating is accomplished by a simple and novel process, all the internal workings being fed from one point.

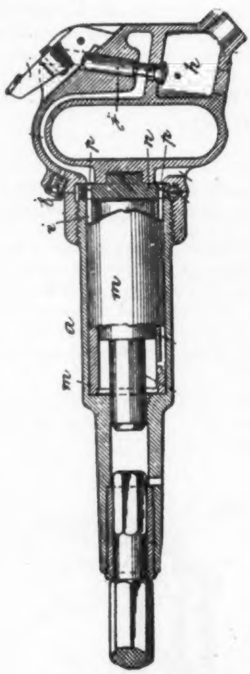
Mr. Thornley claims that his invention may be worked with equal success by compressed air. rendering it invaluable for submarine boats. He declares that its capabilities are beyond even his most sanguine expectations, and that by its means ocean liners would easily beat turbines both in speed and economy. Its chief use, however, he considers will be for heavy road traffic, in which direction it would do more than the work of petrol at half the cost.—*Hardware Trade Journal* (Eng.).

INDEX.

U. S. PATENTS GRANTED JAN., 1904.

Specially prepared for COMPRESSED AIR.

748,568. PNEUMATIC TOOL. Robert L. Ambrose, Tarrytown, N. Y., assignor to Rand Drill Company, New York, N. Y., a Corporation of New York. Filed Mar. 22, 1901. Serial No. 52,280.



A pneumatic hand-tool the combination with a barrel and a handle, separably connected by screw-threads, of a taper key mounted in a transverse way in a portion rigid with one of said members, and in frictional contact with a portion rigid with the other of said members, and provided with means for locking it in position.

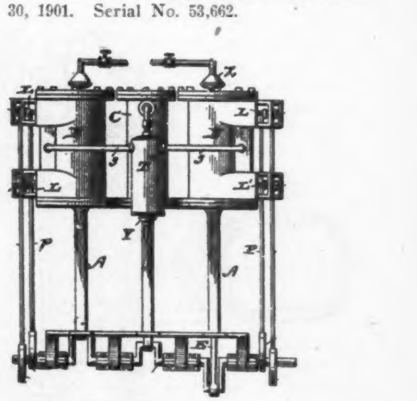
748,575. PNEUMATIC STACKER. Elling O. Berg, Madison, Minn. Filed Mar. 27, 1903. Serial No. 149,809.

The combination with a separator, of a fan in position to receive the straw, and provided with a discharging-stack, the trough extending transversely of the machine, in position to receive the chaff, a fan-case receiving from one end of said trough, a feed-worm working in said trough, and a fan-head secured on the shaft of said feed-worm and working in said fan-case, the said fan-case having a delivery-stack, which is independent of the before-noted stack, substantially as described.

748,640. PNEUMATIC STRAW-STACKER. Nels L. Nelson, Crookston, Minn. Filed Mar. 4, 1903. Serial No. 146,151.

A straw-stacker, the combination of a blower having a lateral opening, and a hopper arranged to direct material toward the lateral opening of the blower and provided at its bottom with an opening to permit heavy objects to drop through the straw-stacker, substantially as described.

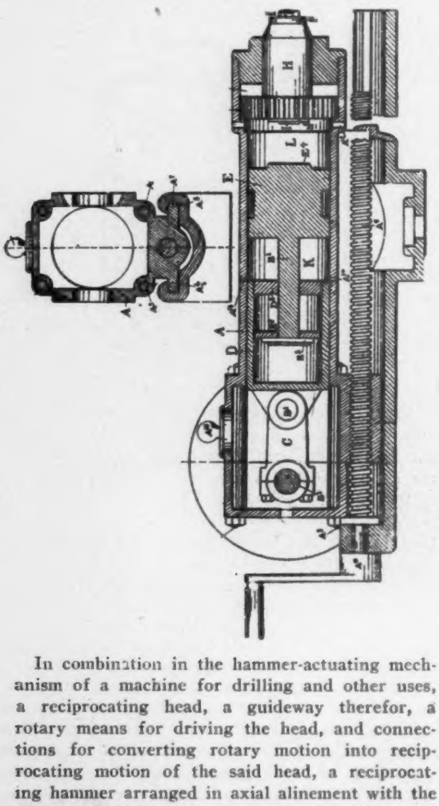
748,660. COMPRESSED-AIR MOTOR. Edward W. Schloemer, Milwaukee, Wis. Filed Mar. 30, 1901. Serial No. 53,662.



A motor comprising two motor-cylinders, pistons therein, each motor-cylinder having two parallel, longitudinal passageways opening into the cylinder on each side of the piston, rotary valves in said passageways adjacent each end thereof, a compressor-cylinder of less diameter than the motor-cylinders and arranged between them, a reservoir-tank, a piston in the compressor-cylinder, pipes leading from each end of the compressor-cylinder to the tank, and thence discharging into one of the longitudinal passages of each motor-cylinder, an exhaust-pipe leading from the other passage, a cranked shaft, piston-rods connected at one end to the pistons, and at their opposite ends to the shaft, two eccentrics arranged on the shaft adjacent each motor-cylinder, eccentric rods extending parallel with each motor-cylinder, oppositely-arranged valve-stems, connected at one end to the valves in one of the passages and at their opposite ends to one of said valve-rods, means for initially compressing the air in the tank and means for heating the motor-cylinders.

748,693. POWER-DRIVEN ROCK-DRILL. William A. Box, Denver, Colo., assignor of one-half to Eugene Y. Sayer, Denver, Colo. Filed Mar. 22, 1901. Serial No. 52,310.

A power-driven rock-drill, the combination of a casing, a rotatable tool supported thereby, a piston movable in the casing independently of the tool and constituting a hammer for striking the tool, an independently movable plunger located in the casing axially in line with the piston and behind the same, and means for reciprocating the plunger in the casing behind said piston to alternately compress the air behind the piston and cause a vacuum behind the same, whereby the piston is actuated to strike the tool and return at each stroke of the plunger, substantially as described.



In combination in the hammer-actuating mechanism of a machine for drilling and other uses, a reciprocating head, a guideway therefor, a rotary means for driving the head, and connections for converting rotary motion into reciprocating motion of the said head, a reciprocating hammer arranged in axial alinement with the said head, and a casing affording provision for the confienement of a body of air between the head and the hammer, for substantially the purposes set forth.

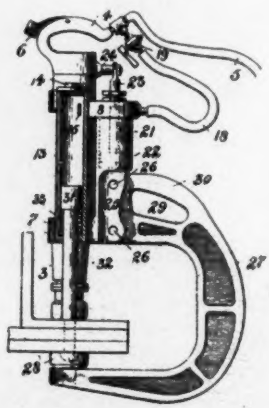
748,733. EMERGENCY AIR-BRAKE. William H. Honsberger, Buffalo, N. Y. Filed Oct. 17, 1903. Serial No. 177,401.

In combination with a straight-air system, an emergency-reservoir, means for charging the same from the regular system, an emergency-valve, piping connecting said emergency-valve with said emergency-reservoir, a valve for opening and closing said connection, said emergency-valve operating to close the train-pipe connection with a brake-cylinder and to establish connection between said brake-cylinder and said emergency-reservoir, substantially as and for the purposes set forth.

748,738. ENGINE-GOVERNOR. Edmund Hudson, Templeton, Mass. Filed Sept. 8, 1902. Serial No. 122,450.

The combination, with a motor; and a cylinder having a series of perforations leading from the inside to the outside thereof; of a member, having similar perforations; and means for shifting said member to regulate the registration of the perforations in the cylinder and said member.

748,816. RIVET-HOLDER. Edward F. Terry, New York, N. Y. Filed May 19, 1902. Serial No. 107,971.

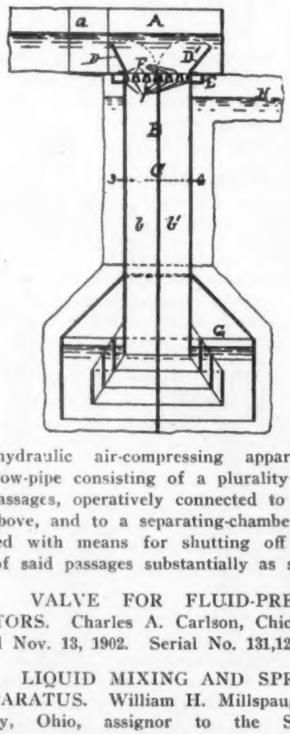


In combination, a gas-operated riveting-hammer, a set whereby the head of the rivet is held during the operation, a pair of clamping members arranged on the same side of the material with the hammer and, respectively, on opposite sides of the hammer and means whereby said set and clamping members are operated inversely to each other.

748,731. LUBRICATOR FOR AIR-BRAKE PUMPS. Thomas M. Henderson, Portsmouth, Va., assignor of two-thirds to Charles Paddock Storrs, Wilmington, Del., and Robert Randolph Hicks, Norfolk, Va. Filed June 27, 1902. Serial No. 113,524.

The combination with the air-cylinder of an air-brake pump, of an exhaust-steam pipe leading from the steam-cylinder into the body of the air-cylinder, substantially as and for the purpose described.

748,898. HYDRAULIC AIR-COMPRESSOR. William O. Webber, Boston, Mass., assignor to Walter C. Carr, New York, N. Y. Filed Jan. 8, 1903. Serial No. 138,195.



A hydraulic air-compressing apparatus, a down-flow-pipe consisting of a plurality of vertical passages, operatively connected to a head-tank above, and to a separating-chamber below, provided with means for shutting off one or more of said passages substantially as specified.

748,928. VALVE FOR FLUID-PRESSURE MOTORS. Charles A. Carlson, Chicago, Ill. Filed Nov. 13, 1902. Serial No. 131,120.

748,971. LIQUID MIXING AND SPRAYING APPARATUS. William H. Millspaugh, Sandusky, Ohio, assignor to the Sandusky Foundry and Machine Company, Sandusky, Ohio, a Corporation of West Virginia. Filed Apr. 22, 1903. Serial No. 153,752.

An apparatus for mixing liquids, a plurality of liquid-tanks, an air-pump having a common connection therewith, outlet-pipes therefrom having a common discharge, and a removable plate in the path of each liquid having an aperture of predetermined size to permit the desired relative rate of flow, substantially as described.

749,121. AUTOMATIC SUCTION-PUMP OR VACUUM-CHAMBER. Charles H. Wettlin, Asbury Park, N. J., assignor of one-half to Asher S. Burton, Asbury Park, N. J. Filed Apr. 2, 1903. Serial No. 150,702.

749,152. PNEUMATIC-DESPATCH SYSTEM. Birney C. Batcheller, Philadelphia, Pa. Filed Apr. 17, 1901. Serial No. 56,177.

A pneumatic-despatch system, the combination with a pneumatic tube of gates for closing the same arranged a sufficient distance apart to give ample space between them for a carrier mechanism for opening and closing said gates actuated by a power other than the compression of air by an advancing carrier, controlling devices whereby the gate-actuating mechanisms are made to operate in different directions, means for actuating said controlling devices to successively close the first and open the second gate set in operation by the approach of a carrier to the second gate, means for actuating the controlling devices to successively close the second and open the first gate set in operation by the passage of a carrier beyond the second gate, an air-outlet passage having connections A3 A4 with the tube on both sides of the first gate, a gate whereby said connections are alternately opened and closed, gate-actuating mechanism for moving said gate and controlling devices for shifting said mechanism connected with the actuating mechanism of the first tube-gate and arranged to connect the opening A4 in the rear of the tube-gate with the air-outlet passage when the said gate is open and to connect the opening A3 in advance of said gate when it is closed.

749,156. VALVE MECHANISM. William A. Bollinger, Allegheny, Pa. Filed Dec. 10, 1902. Serial No. 134,716.

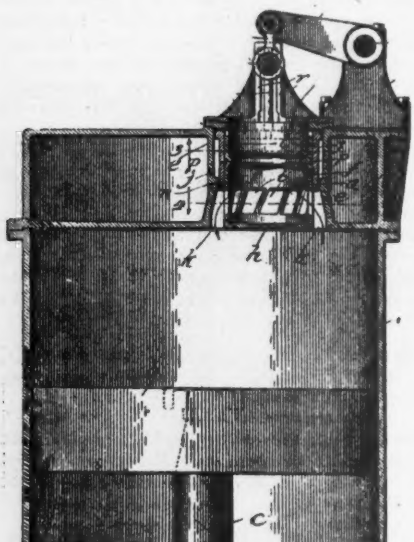
749,262. AUTOMATIC FLUID-PRESSURE BRAKE APPARATUS. Murray Corrington, New York, N. Y. Filed July 1, 1902. Serial No. 113,887.

A fluid-pressure brake mechanism, the combination, with a triple valve having connections leading to a train-pipe, an auxiliary reservoir and a brake-cylinder, respectively, of a supplemental piston for forcing the triple valve into its normal or release position and a second valve device actuated by an increase of fluid-pressure, independently of the movement of the triple-valve piston, for varying the pressures on said supplemental piston, whereby the same may be actuated to force the triple valve into its normal or release position.

749,263. AUTOMATIC FLUID-PRESSURE BRAKE MECHANISM. Murray Corrington, New York, N. Y. Filed July 12, 1902. Serial No. 115,317.

A fluid-pressure brake system, the combination with a primary piston controlling by its movements the admission and exhaust of pressure to and from a brake-cylinder, of a passage for bleeding the auxiliary reservoir to the atmosphere, a secondary piston controlling by its movements said passage, a valve device actuated by a variation of pressure, independently of the movement of the primary piston for controlling the secondary piston and a passage from one side of the secondary piston which is controlled by the operation of both the valve device and the primary piston.

749,323. INLET-VALVE FOR COMPRESSING-ENGINES. Irving H. Reynolds, Milwaukee, Wis. Filed Dec. 15, 1902. Serial No. 135,307.



The combination of an engine, a cylinder-head secured thereto having fixed and removable walls forming an annular valve-chamber therebetween, one of which walls is provided with inlet-perforations, a sleeve-shaped valve in such annular chamber for alternately covering and uncovering the inlet-perforations, and means for actuating said valve during the operations of the engine, substantially as described.

749,488. SAND-BLAST APPARATUS. Willis R. King, New York, N. Y., assignor to the Hanson & Van Winkle Company, a Corporation of New Jersey. Filed May 21, 1903. Serial No. 158,093.

A sand-blast apparatus, the combination, with a casing, of means connected with said casing for receiving an abrading material, and emitting the same in a jet, and means connected therewith for conducting a jet of air directly into the interior of the jet of abrading material for mixing the same with the air and admitting the same under pressure into said casing, substantially as and for the purposes set forth.

749,519. AIR-GUN. Walter R. Benjamin, St. Louis, Mo. Filed June 10, 1902. Serial No. 111,048.

749,637. VALVE. Frank L. Smith, Chicago, Ill., assignor, by direct and mesne assignments, of two-thirds to Alva C. Ricksecker and Lewis A. Nichols, Chicago, Ill. Filed Feb. 24, 1903. Serial No. 144,629.

749,737. PNEUMATIC STACKER. Joseph H. Ley, Kellogg, Minn. Filed July 22, 1903. Serial No. 166,600.

A pneumatic straw-stacker, a conveyor-tube having a hinged spring-actuated hood with a depending flange at its outer end, said conveyor-tube and hood being provided with alining longitudinally-flanged discharge-openings.

749,750. VALVE. James J. Rylands, Homestead, Pa., assignor to Homestead Valve Manufacturing Company, a Corporation of Pennsylvania. Filed Oct. 24, 1903. Serial No. 178,307.

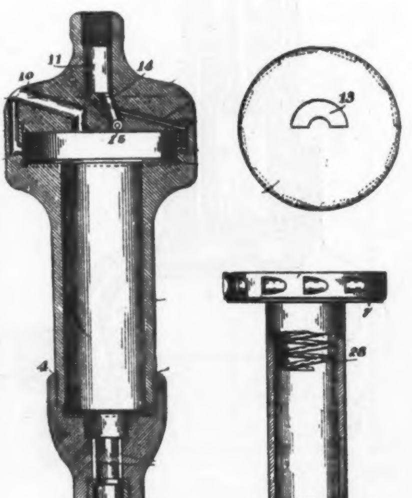
749,767. PROCESS OF PRODUCING CARBURETED AIR. Edward F. Wilson, Chicago, Ill., assignor to George S. Welles, Chicago, Ill. Filed Oct. 19, 1903. Serial No. 177,642.

The process of producing carbureted fluid which consists in introducing a hydrocarbon fluid and air into a sealed vessel at opposite ends, causing the same to flow continuously in opposite directions through said vessel in a zigzag direction, finely dividing said liquid throughout its passage, and simultaneously atomizing said liquid and agitating said air at one point in their passage through said vessel.

749,768. APPARATUS FOR PRODUCING CARBURETED AIR. Edward F. Wilson, Chicago, Ill., assignor to George S. Welles, Chicago, Ill. Filed Oct. 19, 1903. Serial No. 177,643.

An apparatus for generating gas, the combination with a source of supply of a hydrocarbon liquid and a source of supply of air under pressure, of a carbureter comprising a sealed vessel having connection with said source of supply of liquid at its upper end and with said source of supply of air at its lower end, alternately-oppositely-inclined relatively-staggered plates, mounted one above the other in said vessel and over which the liquid passes zigzag through said vessel, an outlet for the carbureted air at the upper end of said vessel, and devices interposed in the path of said liquid below the delivery end of one of said plates for atomizing said liquid and agitating the air, substantially as described.

749,808. PNEUMATIC HAMMER. Clyde A. Speer and Eugene C. Bowman, Los Angeles, Cal. Filed May 28, 1903. Serial No. 159,181.



The combination with a reciprocating hammer, of a rotary cylinder, and means for applying fluid-pressure to the cylinder to cause it to move and means connected with the cylinder for applying fluid-pressure to the hammer.

749,810. AIR-BRAKE SAFETY DEVICE. Charles Truman, Toledo, Ohio. Filed July 23, 1903. Serial No. 166,682.

An air-brake attachment consisting of a casing adapted to be connected at one end with a train-pipe and at its other end to an air-hose and having on the under side of its interior a recess, a ball which rests normally in said recess, a wall across the interior of the casing having an air-passage therethrough which forms a valve-seat for the ball, and means for permitting a retarded flow of air around the ball when in closed position.

749,859. VALVE FOR AIR-BRAKES. Timothy Haley, Xenia, Ohio. Filed Aug. 5, 1903. Serial No. 168,386.

In combination with the auxiliary reservoir, a valve-casing connected at one end with the said reservoir and connected at the other end with the release part, said casing having an outlet for the escape of air, and a double-headed valve arranged in the said casing and subjected to the pressure from the release part and the auxiliary reservoir, substantially as described.

749,974. FLUID-PRESSURE-REGULATING DEVICE. Paul Synnestvedt, Glenview, Ill., assignor to Westinghouse Air Brake Company, Wilmerding, Pa., a Corporation of Pennsylvania. Filed Dec. 13, 1900. Serial No. 40,705.

The combination with a valve casing having an inlet and outlet and a valve seat, of a puppet valve, a movable abutment of larger area than the puppet valve, adjustable connections between the movable abutment and the puppet valve positively moving said valve both to and from its seat, but provided with means for play of motion between the two, the said abutment being placed upon the outlet side of the valve, whereby the low pressure side operates to positively seat the valve and said abutment may make small motions without moving the valve off its seat, substantially as described.

749,975. FLUID-PRESSURE-REGULATING DEVICE. Paul Synnestvedt, Glenview, Ill., assignor to Westinghouse Air Brake Company, Wilmerding, Pa., a Corporation of Pennsylvania. Filed Dec. 21, 1900. Serial No. 40,706.

A pressure regulating device the combination with a casing having a main chamber and an inlet and an outlet port, of a boss extending into said chamber carrying a conical valve seat and loose puppet valve seated therein, a movable abutment in said main chamber subject to pressure on the outlet side of the valve and guided to move in vertical guides, and a yoke surrounding said boss, connected directly to the movable abutment and adapted to positively close the valve on its seat, substantially as described.

749,990. VALVE. Emil F. Holinger, McKeesport, Pa. Filed Sept. 25, 1903. Serial No. 174,586.

750,010. AIR-BRAKE. George Westinghouse, Pittsburg, Pa., assignor to the Westinghouse Air Brake Company, Pittsburg, Pa., a Corporation of Pennsylvania. Filed June 2, 1903. Serial No. 159,744.

An air-brake, the combination with a main reservoir and train-pipe, of an electrically-operated release-valve device for controlling communication from the main reservoir to the train-pipe and means within reach of the motorman for controlling the opeation of said release-valve device.

The combination with a main reservoir, train-pipe and brake-valve, of a separate release-valve for controlling communication from the main reservoir to the train-pipe, an electromagnet-valve for governing the action of the release-valve, and switch-contacts operated by the movement of the brake-valve for closing the circuit to said electromagnet when the brake-valve handle is in release position.

750,031. BRAKE-RELEASING DEVICE. Philip B. Harrison and Charles F. Huntoon, Chicago, Ill., assignors to Chicago Railway Equipment Company, Chicago, Ill., a Corporation of Illinois. Filed Sept. 21, 1903. Serial No. 174,038.

An air-brake, the combination with a cylinder and its piston, of a push-bar disconnected from the piston, and means located in the cylinder for restoring the push-bar upon the release of the brakes, substantially as described.

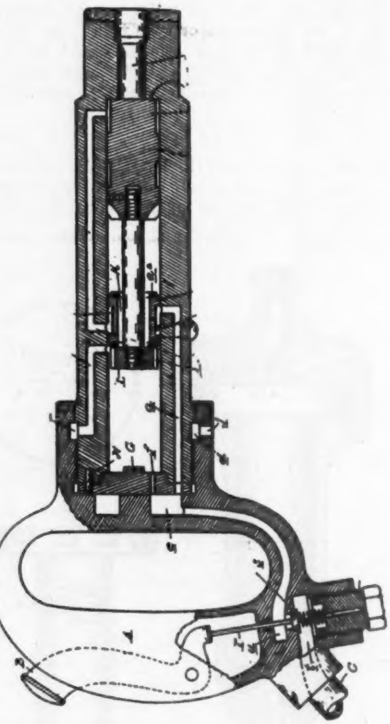
750,128. VALVE. John E. Schneider, Allegheny, Pa. Filed Nov. 14, 1902. Serial No. 131,402.

750,356. PNEUMATIC CONVEYER. Melvin J. Foyer, Chicago, Ill., assignor, by mesne assignments, to Bostedo Pneumatic Tube Company, Chicago, Ill., a Corporation of Illinois. Filed June 6, 1900. Serial No. 19,215.

A pneumatic conveyer, the combination of a distributing-tube, a collecting-tube connected with the distributing-tube near the delivery end of the same, a despatching-door for said collecting-tube, an air-admission valve on the distributing-tube connected with said door, means for controlling the period of closing the said air-admission valve, an inwardly-seating valve at the delivery end of said distributing-tube, and means for applying suction to said collecting-tube near its delivery end.

750,236. PNEUMATIC TOOL. Luke W. Turnbull, Port Huron, Mich. Filed April 27, 1903. Serial No. 154,547.

A pneumatic tool, the combination of a cylinder, a tubular piston-controlling valve fitting in said cylinder, a rod movable through said valve without contact, and a piston and a collar at opposite ends of said rod for actuating said valve.

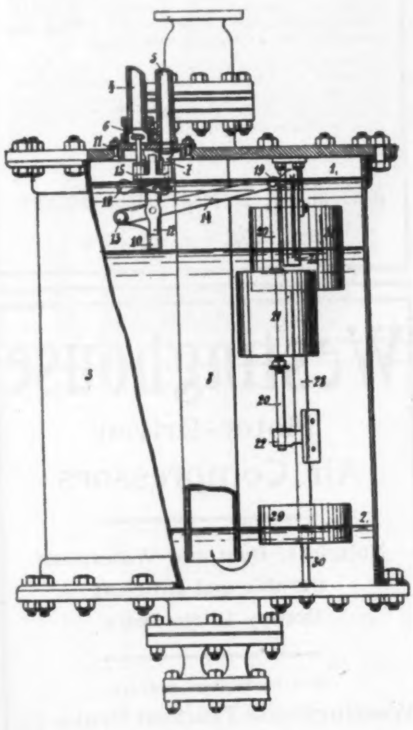


A fluid-actuated tool, a cylinder having a fluid-supply port and a by-pass port, a tubular valve for permitting the passage of the fluid from the supply-port through said valve to one end of the cylinder, said valve having an exterior annular chamber for permitting the passage of the fluid from said supply-port around said valve and through the by-pass port to the other end of the cylinder, a piston reciprocating in said cylinder, a rod attached to said piston passing through said valve without contacting with the same and a collar on the other end of said rod, said collar and piston serving to actuate said valve.

750,249. PROTECTIVE BAND FOR PNEUMATIC TIRES. Harry Brookes, Stirchley, near Birmingham, England. Filed August 8, 1903. Serial No. 168,838.

750,321. VALVE. William H. Thompson, London, England. Filed July 11, 1902. Serial No. 115,114.

750,326. PNEUMATIC FLUID ELEVATOR OR PUMP. Antonio Montenegro y Van-Halen, Madrid, Spain. Filed March 24, 1903. Serial No. 149,320.



Apparatus for raising liquid by compressed air comprising a closed chamber provided with liquid and air inlet and outlet, valves governing the air-inlet and air-outlet, a valve-operating lever, a float for actuating said lever, two catches adapted to engage the valve-lever in its raised and in its depressed positions respectively, a lever for operating said catches, and a float actuating the last-mentioned lever, the said catches being simultaneously operated through said last-mentioned lever and float, the one to release and the other to be free to engage said valve-lever as the last-named float reaches the end of its upward or downward stroke.

750,366. PNEUMATIC DRY ORE-SEPARATOR. Edwin M. Jahraus, Dayton, Ohio. Filed Oct. 15, 1902. Serial No. 127,404.

The combination, with suitable supports and a horizontal axis, of an ore-separator box having pendent arms which are journaled on such axis, an eccentric on such axis, a jointed piston-rod connected with the said eccentric, an air-piston arranged in the box and reciprocated through the medium of the piston-rod, a toothed arc formed on the side of one of the pendent arms, a hand worm-shaft journaled on one of the fixed supports, its worm engaging the toothed arc, as shown and described.

750,379. PNEUMATIC-TIRED WHEEL. Theodore Lindenberg, Columbus, Ohio. Filed Aug. 18, 1902. Serial No. 120,011.

750,433. CARBURETER. Harry B. Cornish, Minneapolis, Minn., assignor of two-thirds to I. D. Cooper, R. G. Ford, and W. E. Ford, Minneapolis, Minn. Filed Oct. 19, 1903. Serial No. 177,512.

A carbureter comprising an outer member, an inner member inclosed by said outer member and spaced therefrom and having an air-passage communicating with said space and the interior of said inner member, means for feeding gasolene or other volatile fluid into the space between said members and past the discharge end of said passage, and means for supplying air under pressure to said inner member and said passage.

750,571. PNEUMATIC SEAT. Charles L. Berger, Richmond, Ind., assignor of one-half to Ray Morrow, Minneapolis, Minn. Filed Aug. 18, 1902. Serial No. 119,995.

750,617. AIR-DOOR. John T. Deviese, Crownhill, W. Va. Filed July 30, 1903. Serial No. 167,635.

A mine air-door, the combination, with the hinged door-plates provided with arms, of a bar operatively connected with the said arms, an armature carried by the said bar, and an electromagnet for attracting the armature and opening the door.

750,633. MULTIPLE - TUBE PNEUMATIC TIRE. Henry G. Fiske, New York, N. Y., assignor, by mesne assignments, to Morton Trust Company, trustee, a Corporation of New York. Filed June 17, 1899. Serial No. 720,914.

750,667. VACUUM-FRAME. Oscar I. Lewellyn and James W. Schock, Kokomo, Ind. Filed Aug. 24, 1903. Serial No. 170,657.

A vacuum-frame having a plurality of suction-holders, a single means for exhausting air therefrom, and means controlled by the outside air-pressure for stopping the exhaust.

750,738. HOOD FOR PNEUMATIC STACKERS.. Ira A. Weaver, Springfield, Ill., assignor of one-half to Samuel E. Prather and Clyde A. Sattley, Springfield, Ill. Filed May 11, 1903. Serial No. 156,689.

A hood for pneumatic stackers, consisting of a drum provided with means for imparting circular motion to the discharge from the stacker-tube, an upper discharge-opening, a depending perforated collar mounted within the upper discharge-opening, and a lower discharge-opening, substantially as and for the purposes specified.

750,764. CARBURETER. Frederic Harmany, Marietta, Ohio, assignor, by direct and mesne assignments, of part to Ida M. Butts, James McCormick, Forrest Clymer and James B. McCormick, Marietta, Ohio. Filed Nov. 24, 1902. Serial No. 132,612.

The combination in a device for vaporizing and burning hydrocarbon oil, of a mixing-chamber provided with a fixed abutment, a discharge-orifice within the chamber below the abutment, means for forcing a fine stream or jet of oil through the discharge-orifice upwardly against said abutment, by which it is deflected downward in the form of spray or vapor, means for introducing air under pressure into the mixing-chamber below the discharge-orifice to mix with the spray or vapor, a retort-vaporizer, a connection from the mixing-chamber to the retort-vaporizer for conveying the mixture thus formed to the retort-vaporizer, and a burner connected with the retort-vaporizer and arranged to heat the same; substantially as described.

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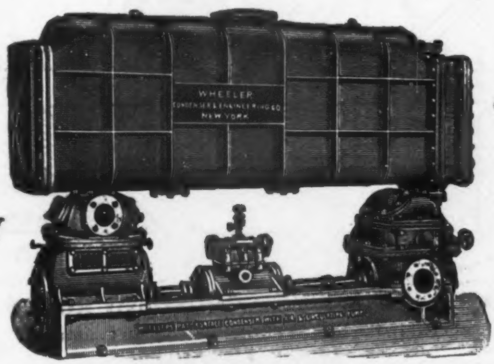

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